Department of Civil Engineering

Minutes – 12th Meeting of Board of Studies (BOS)
Wednesday, the 20th Feb, 2019

Following faculty members were present for the meeting*:

1. Prof. S P Singh, Professor and Head, Department of Civil Engineering, NIT Jalandhar (SPS)
2. Prof. A P Singh, Professor, Department of Civil Engineering, NIT Jalandhar (APS)
3. Prof. A K Agnihotri, Professor, Department of Civil Engineering, NIT Jalandhar (AKA)
4. Dr. R. K. Sharma, Professor, Department of Civil Engineering, NIT Hamirpur (RKS)
5. Prof. A Mukhopadhyay, Dean (Academic), NIT Jalandhar (AMY)
6. Dr. Ajay Bansal, Professor, Department of Chemical Engineering, NIT Jalandhar (ABL)
7. Dr. Vishal Sharma, Professor, Department of Industrial and Production Engineering (VSM), NIT Jalandhar
8. Dr Hemant S.Chore, Associate Professor, Department of Civil Engineering, NIT Jalandhar
9. Mr. Charanpreet Singh, Additional Superintending Engineer, Bhakra Beas Management Board, Nangal, PB (CPS)
10. Dr. Davinder Singh, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (DS)
11. Mrs. Shailja Bawa, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (SB)
12. Dr. Amit Kumar, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (AKR)
13. Dr. Kanish Kapoor, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (KK)
14. Dr Mahesh Patel, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (MP)
15. Dr. Navdeep Singh, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (NS)
16. Dr. Rajiv Kumar, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (RK)
17. Dr. Rupali Satavalekar, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (RUS)
18. Dr. Senthil Kasilingam, Assistant Professor, Department of Civil Engineering, NIT Jalandhar (SK)

*Dr. N. K. Samadhiya, Professor, IIT Roorkee were not able to attend due to his preoccupations.

First, Prof. S. P. Singh, Chairman, BOS welcomed the participants of the 12th meeting of BOS, Civil Engineering Department, NIT Jalandhar and initiated the proceedings.

Item 12.1 Revised teaching scheme and syllabus for B. Tech.

a. Certain modifications were suggested in the meeting by the members and experts (AKA, RKS, APS).
b. The modifications have been incorporated and approved and final version is appended as Enclosure #1

Item 12.2 Revised teaching scheme and syllabus for minor degree in Civil Engineering (Enclosure #2)

a. The courses for minor degree have been selected as per the institute requirement of selecting at least one course from each semester.

b. Item was approved and final version is appended as Enclosure #2

Item 12.3 Revised teaching scheme and syllabus for M.Tech. (Structural & Construction Engineering) (Enclosure #3)

a. A new elective “Modelling and Research methodology” has been suggested and incorporated in the list of electives.
b. Item was approved and final version is appended as Enclosure #3.

Item 12.4 Revised teaching scheme and complete syllabus for M.Tech. (Geotechnical & Geoenvironmental Engineering) (Enclosure #4)

a. Item was approved and final version is appended as Enclosure #4

Item 12.5 Teaching scheme and syllabus for PG Diploma in Civil Engineering

a. Scheme and syllabus were approved for two specializations: (i) Structural & Construction Engineering, (ii) Geotechnical and Geoenvironmental Engineering
b. Item was approved and final version is appended as Enclosure #5 (a) and 5 (b)

Item 12.6 Any other point with the permission of chair

a. Proposal for M.Tech. (Transportation Engineering)
    i. The proposal has been deferred to the next BOS meeting.
    ii. It was also decided that the next M.Tech. program to be offered in the department will be MTech (Transportation Engineering), subject to approval from the institute.
b. Amendment of Vision , Mission and PEOs statements
    i. It was decided that the existing vision, mission and PEOs are relevant and there is no need for a change.

Meeting ended with vote of thanks to everyone.

(Amit Kumar)

Assistant Professor and Secretary (Board of Studies)

Head, Civil Engineering Department and Chairman (Board of Studies)

Enclosures:

1. Teaching scheme and syllabus for BTech in Civil Engineering
2. Teaching scheme and syllabus for minor degree in Civil Engineering

3. Teaching scheme and syllabus for M.Tech. (Structural & Construction Engineering)
4. Teaching scheme and syllabus for M.Tech. (Geotechnical & Geoenvironmental Engineering)
5. Teaching scheme and syllabus for PG Diploma in Civil Engineering: (a) Structural & Construction Engineering specialization, (b) Geotechnical & Geoenvironmental Engineering specialization

Teaching scheme and syllabus for BTech in Civil Engineering

Enclosure #1

CURRICULUM

3^{rd} – 8^{th} Semester July 2018 admission onwards

APPROVED BY

BOARD OF STUDIES (BOS)

12^{th} MEETING, February 20^{th}, 2019

B. Tech. in Civil Engineering: Revised Teaching Scheme

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

Phone: 0181-2690301, 02 (Ext. 2101, 2104), Fax: 0181-2690932 Website: www.nitj.ac.in

B.Tech. in Civil Engineering

Programme Core (PC): 93, Programme Elective (PE): 15, Open elective (OE): 09, Core Institute (CI): 63 (1st Year 47, 4th Semester Mathematics and Humanities course 07, Projects 06, Industrial lecture 01, Practical Training: 02), Total Credit: 180

First and Second Semester, Total Credit: 50

I Semester

Course Code	Subject	L	T	P	Contact hours	Credits
PHCI-101	Applied Physics	3	1	0	4	4
CECI-101	Elements of Civil Engineering	3	1	0	4	4
CSCI-101	Computer Programming	3	0	0	3	3
MACI-101	Applied Mathematics - I	3	1	0	4	4
HMCI-101	Management, Principles and Practice	3	0	0	3	3
MECI-101	Engineering Graphics & CADD	3	0	0	3	3
PHCI-102	Physics Laboratory	0	0	2	1	1
CSCI-102	Computer Programming Laboratory	0	0	2	2	1
Total						**23 Total**

II Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CYCI-101	Applied Chemistry	3	1	0	4	4
MACI-102	Applied Mathematics - II	3	1	0	4	4
MECI-101	Elements of Mechanical Engineering	3	1	0	4	4
HMCI-102	English Communication & Report Writing	3	0	0	3	3
IPCI-101	Manufacturing Process	2	0	0	2	2
CYCI-104	Environmental Science and Technology	3	0	0	3	3
HMCI-103	English Communication Laboratory	0	0	2	2	1
CYCI-103	Applied Chemistry Laboratory	0	0	2	2	1
IPCI-102	Product Realization through Manufacturing Laboratory	0	0	4	4	2
Total						**24 Total**

III Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CEPC-201	Highway and Traffic Engineering	3	1	0	4	4
CEPC-203	Surveying	3	1	0	4	4
CEPC-205	Concrete Technology	3	0	0	3	3
CEPC-207	Strength of Materials	3	1	0	4	4
CEPC-209	Building Construction	2	0	0	2	2
CEPC-211	Water Supply Engineering	3	1	0	4	4
CEPC-221	Highway and Traffic Engineering Laboratory	0	0	2	2	1
CEPC-223	Concrete Technology Laboratory	0	0	2	2	1
CEPC-225	Surveying Laboratory	0	0	2	2	1
Total						**Core – 24** **Total - 24**

IV Semester

Course Code	Subject	L	T	P	Contact hours	Credits
HMCI-304	Human Resource Management and Industrial Relations	3	0	0	3	3
MACI-203	Numerical Methods	3	1	0	4	4
CEPC-202	Structural Analysis-I	3	1	0	4	4
CEPC-204	Wastewater Engineering	3	1	0	4	4
CEPC-206	Earth Sciences	3	0	0	3	3
CEPC-208	Fluid Mechanics	3	1	0	4	4
CEPC-222	Fluid Mechanics Laboratory	0	0	2	2	1
CEPC-224	Structural Analysis-I Laboratory	0	0	2	2	1
CEPC-226	Wastewater Engineering Laboratory	0	0	2	2	1
CEPC-230	Survey Camp*	-	-	-	-	2
Total						**Core – 20** **Total - 27**

*The students will undergo Survey Camp (2-3 weeks) during the summer vacation in a hill station.

V Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CEPC-301	Design of Concrete Structures-I	3	1	0	4	4
CEPC-303	Railway, Airport and Harbour Engineering	3	0	0	3	3
CEPC-305	Soil Mechanics	3	1	0	4	4
CEPC-307	Structural Analysis-II	3	1	0	4	4
CEPC-309	Construction Management	3	0	0	3	3
CEPC-311	Irrigation Engineering	3	0	0	3	3
CEPC-321	Soil Mechanics Laboratory	0	0	2	2	1
CECI-301	Minor Project, Phase-I	0	0	2	2	0*
Total						**Core - 22** **Total - 22**

VI Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CEPC-302	Foundation Engineering	3	1	0	4	4
CEPC-304	Design of Concrete Structures-II	3	0	0	3	3
CEPC-306	Design of Steel Structures-I	3	1	0	4	4
CEPC-308	Elements of Earthquake Engineering	3	1	0	4	4
CEPE-XXX	Departmental Elective-I	3	0	0	3	3
CEOE-XXX	Open Elective-I	3	0	0	3	3
CEPC-322	Concrete Structures-II Drawing	0	0	2	2	1
CECI-302	Minor Project, Phase-II	0	0	2	2	2*
Total						**Core - 16** **Total - 24**

* Minor Project will be allotted in 5th Semester, will be evaluated after 6th Semester

VII Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CEPC-401	Design of Hydraulic Structures	3	0	0	3	3
CEPC-403	Design of Steel Structures-II	3	0	0	3	3
CEPE -XXX	Departmental Elective-II	3	0	0	3	3
CEPE-XXX	Departmental Elective-III	3	0	0	3	3
CEOE-XXX	Open Elective–II	3	0	0	3	3
CEPC-421	CAD Laboratory	0	0	2	2	1
CEPC-423	Hydraulic Structures Drawing	0	0	2	2	1
CECI-300	Industrial Practical Training*	0	0	0	0	2*
CECI-400	Major Project (Phase-I)	0	0	4	4	0
Total						**Core - 08** **Total - 19**

* Industrial Practical Training will be held during summer vacation after sixth semester

VIII Semester

Course Code	Subject	L	T	P	Contact hours	Credits
CEPC-402	Estimating and Costing	3	0	0	3	3
CEPE-XXX	Departmental Elective-IV	3	0	0	3	3
CEPE- XXX	Departmental Elective-V	3	0	0	3	3
CEOE-XXX	Open Elective-III	3	0	0	3	3
CECI-402	Industrial Lecture	1	0	0	1	1
CECI-400	Major Project (Phase-II)	0	0	8	8	4*
Total						**Core - 03** **Total - 17**

* Major Project will be allotted in 7th Semester, will be evaluated after 8th Semester

List of Departmental Electives

(A) Semester VI: Departmental Elective I

01 subjects out of following group:

Course Code	Subject	L	T	P	Contact hours	Credits
CEPE-332	Plastic Analysis of Structures	3	0	0	3	3
CEPE-334	Structural Analysis-III	3	0	0	3	3
CEPE-336	Hydrology and Dams	3	0	0	3	3
CEPE-338	Advanced Construction Practices	3	0	0	3	3
CEPE-340	Elements of Remote Sensing and GIS	3	0	0	3	3
CEPE-342	Highway Pavement Design and Construction	3	0	0	3	3
Total						

(B) Semester VII: Departmental Elective II, III

02 subjects out of following group:

Course Code	Subject	L	T	P	Contact hours	Credits
CEPE-431	Advanced Foundation Engineering	3	0	0	3	3
CEPE-435	Industrial Structures	3	0	0	3	3
CEPE-437	Pre-stressed Concrete Design	3	0	0	3	3
CEPE-439	Finite Element Methods in Engineering	3	0	0	3	3
CEPE-441	Architecture & Town Planning	3	0	0	3	3
CEPE-449	Smart Cities	3	0	0	3	3
CEPE-453	Environmental Geo-technology	3	0	0	3	3
CEPE-455	Traffic Engineering and Management	3	0	0	3	3
CEPE-457	Hydraulics and Hydraulic Machines	3	0	0	3	3
Total						

(C) Semester VIII: Departmental Elective IV, V

02 subjects out of following group:

Course Code	Subject	L	T	P	Contact hours	Credits
CEPE-432	Bridge Engineering	3	0	0	3	3
CEPE-434	Soil Dynamics	3	0	0	3	3
CEPE-436	Hydro Power Engineering	3	0	0	3	3
CEPE-438	Software Applications in Structural Engineering	3	0	0	3	3
CEPE-440	Ground Improvement and Ground Engineering	3	0	0	3	3
CEPE-444	Quantitative Methods in Civil Engineering	3	0	0	3	3
CEPE-446	Advanced Environmental Engineering	3	0	0	3	3
CEPE-448	Advanced Civil Engineering Materials	3	0	0	3	3
CEPE - 450	Fluvial Hydrodynamics	3	0	0	3	3
CEPE-452	Rural Roads	3	0	0	3	3
Total						

Open Electives Courses to be offered by the Department of Civil Engineering for Other Department students:

Course No	Course Title	L	T	P	Credits	Remarks
CEOE-370	Ecology and Environment	3	0	0	3	offered in 6th, 7th and 8th Semester
CEOE-471	Disaster Management	3	0	0	3	
CEOE-472	Green Technology	3	0	0	3	

Syllabus
for
Bachelor Degree in Civil Engineering

THIRD SEMESTER

CEPC-201 **Highway and Traffic Engineering** **3 1 0 4**

Course Objectives

1. To give insight of the various facets of the Highway Engineering, importance and role of the transportation system as a whole and highway engineering vis-à-vis other modes of transportation.

2. To familiarize the learner with the historical development in the field of road construction right from ancient and medieval times upto the modern era, development taking place in the field of highway engineering in the Indian context including various agencies involved in the highway engineering and the roles being played by them.

3. To familiarize the learner with the various studies required for the highway planning and alignment and location surveys along with other allied surveys, preparation of the report for highway projects

4. To familiarize the learner to understand the phase of engineering which deals with the planning, analysis and design of the geometric features of the streets, geometrics design of streets, highways, abutting land and with traffic operations thereon w.r.t. safe, convenient and economic transportation of people and goods.

5. To familiarize the learner about the various traffic surveys / studies required to be conducted for collecting, processing, analyzing the data and interpretation of the results thereof for planning and designing the geometric features of the streets, highways and planning the transportation network or systems or component thereof.

6. To enable the learner to study the properties of the different materials to be used in the construction of highways and other allied structures, characterize the materials and evaluate their suitability for application in construction.

7. To make the leaner understand about the classification and behaviour of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements and the design of pavements.

8. To familiarize the learner about the construction of various types of road pavements, distresses in pavements; and maintenance and rehabilitation of pavements.

Course Curriculum

Introduction: Importance and role of transportation systems; different modes of transportation, historical development of road construction , brief history of road development in India; overview of various roads development programmes in the country and present status thereof, different programmes being exceuted by the various agencies, classification of roads according to different criteria.

Highway Planning, Alignment and Surveys

Various surveys for planning of the highway, highway alignment, basic requirements of an ideal alignment, factors governing the alignment, different types of surveys for locating highway.

Highway Geometric Design: Factors governing the design of geometric features, cross-sectional elements, camber, sight distance-definition analysis of stopping sight and passing sight distances, passing zones. Design of horizontal alignment-super elevation. Extra widening on curves, transition curves. Design of vertical alignment, gradients, types of vertical curves and their design

Traffic Engineering-Traffic Engineering studies (speed, volume, O & D, parking and accident studies), traffic signs, traffic signals, road markings, road intersection, highway lighting.

Highway Materials: Different materials for subgrade, sub-base, base course and surface/ wearing course, desirable properties of these materials for different types of pavements, various tests to be conducted for evaluating their suitability as an highway construction materials, requirements as per codal provisions

Pavement Design:

Different types of pavements, comparison between them vis-à-vis based on the structural behaviour and other parameters, factors affecting design of pavements, Various approaches of designing the pavement and methods falling under each category, analysis and design of pavement (flexible and rigid) using IRC method.

Highway Construction, Distresses and Maintenance: Construction of different types of pavements (flexible and rigid, Semi-rigid, composite, etc.), low cost and low volume roads, stabilized roads, bituminous surface treatment, etc.; distresses (failure) in pavements, maintenance including strengthening of the pavement.

Course Outcomes

Upon the successful completion of the course, the leaner shall be able to:

1. Know the various modes of transportation, their significance in the nation's building.
2. Know the development taking place in the field of highway construction until recent time.

3. Know the development in the field of highway engineering in the country and the present status thereof along with the role played by various agencies in the field.
4. Know different studies required to be carried out for highway planning, factors to be considered for highway alignment; and various surveys to be carried out for highway alignment along with the project preparation.
5. Know the cross-section elements of highway or road, different geometric features of the highway, factors affecting the design of the geometric features.
6. Understand the analysis and design of geometric features of the highway.
7. Be familiarized with different traffic studies/ surveys required to be carried out for the planning of the transportation network/ transportation system and geometric design of the streets and highways.
8. Understand as to how to conduct the traffic surveys and analyze the data to be used in the transportation/ traffic planning and geometric design.
9. Understand the properties of the various materials to be used in the construction of different types of pavements/ roads, their characterization and suitability for utilization in the construction.
10. Study the factors affecting the design of different types of pavement and analyze and design the pavements.
11. Know the construction of different types of roads/ pavements including the technique and procedure, failures in different types of pavements, maintenance and rehabilitation thereof.

Books Recommended:

1. Khanna, S.K., Justo, C.E.G. and Veeraragavan, A. 2014. Highway Engineering. Nem Chand and Bros., Roorkee (Revised 10th Edition)
2. Kadiyali, L.R. and Lall, N.B., 2005. Principles and Practice of Highway Engineering. Khanna Publishers, Delhi.
3. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering. CBS Publishers and Distributors.
4. Sriniwaskumar, R.A., 2013. Text Book of Highway Engineering. University Press, Hyderabad.
5. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering. University Press, Hyderabad.
6. Rao, G.V., 2000. Principles of Transportation and Highway Engineering. Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
7. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering). S. Chand and Company Pvt. Ltd., New Delhi.
8. Chakraborty, Partha and Das, Animesh, 2013. Principles of Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi

Reference Books:

1. Kandhal, Prithvi Singh, 2016. Bituminous Road Construction in India:*;* PHI Learning Pvt. Ltd., Delhi
2. Papacostas, C.S. and Prevedouros, P.D., 2012.Transportation Engineering and Planning. Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Khisty, C.J. and Lall, Kent, B. 2018. Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi.
4. Srinivasakumar, R., 2015. Pavement Design. University press, Hyderabad (First Published 2013; Preprinted in 2015).

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Planning related aspects in the context of Highway Geometrics/ Traffic Planning/ Pavement Design and Highway Construction).

Note: Some of the recent specifications may not have been incorporated in few books. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes shall be referred to.

CEPC-203	**Surveying**	**3 1 0 4**

Course Objectives

- At the end of the course the student wills possess the knowledge about Chain surveying, Compass surveying, Plane table surveying, Levelling, Theodolite surveying and Engineering surveys.
- To apply knowledge of mathematics, science, and engineering to understand the measurement techniques and equipment used in land surveying.
- Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

Introduction: Definition, classification of surveys, principle, distorted or shrunk scales, precision in surveying. Different type of surveying: Chain Surveying, Compass Surveying and Plane Table Surveying.

Levelling: Definitions of terms used in levelling, different types of levels, parallax, adjustments, bench marks, classification of levelling, booking and reducing the levels, rise and fall method, line of collimation method, errors in leveling, permanent adjustments, corrections to curvature and refraction, setting out grades, longitudinal leveling, and profile leveling. Automatic Levels.

Contouring: Definition, representation of reliefs, horizontal equivalent, contour interval, characteristics of contours, methods of contouring, contour gradient, Interpolation of contours, uses of contour maps. Contouring by using total station and theodolite.

Hydrographic Surveying: Objects, applications, Establishing controls, Shore line survey, Sounding, Sounding Equipment, Methods of locating soundings - conventional and using GPS , Reduction of soundings, Plotting of soundings, Nautical Sextant and its use, Three point problem and its use, solution of three point problem by all methods, Tides and tide gauges, determination of MSL.

Remote Sensing and Geographical Information System:

Remote Sensing Introduction and definition, Necessity, importance and use of remote sensing, Difference between Aerial photograph and satellite image, Manual & digital image interpretation, Elements of visual image interpretation such as size, shape, tone, texture, etc. Field verification or Ground truthing. Advantages and limitations of RS, Different applications of RS- (Land use and land cover mapping, Disaster management Flood & Earth Quake, and Resource Inventory management,) Digital Image processing, its objectives and different steps in it. Introduction to LIDAR & Underground utility Survey.

Geographical Information System -Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management, querry & analysis and visualization) of GIS. Coordinate systems and projections, Georeferencing, GIS data - spatial (Raster & vector) & a spatial data.

Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of a spatial data. Applications of GIS such as Visibility analysis, Slope analysis, Watershed analysis. & Preparation of thematic maps. Limitations of GIS.

Course outcomes

- Knowing the concept of survey, its classification and principle.
- To learn the different methods of surveying and their applications.
- Understood the errors in traversing, their propagation and adjustment.
- Able to book and reduce field observations.
- Able to use advance equipment like total station, GPS etc. for traverse measurements.
- Understood the use of astronomy in surveying and measurements from aerial photographs.

Text and Reference Books:

1) Punmia B.C, 2018. "Surveying" Vol.1, Laxmi Publications Pvt. Ltd., New Delhi.
2) Punmia B.C, 2018. "Surveying" Vol.2, Laxmi Publications Pvt. Ltd., New Delhi.
3) Kanetkar T.P and Kulkarni S.V, 2016. “Surveying and leveling” Vol. I, VGP, Pune.
4) Kanetkar T.P and Kulkarni S.V, 2016 “Surveying and Leveling” Vol. II, VGP, Pune.
5) Basak N N, 2017. “Surveying and leveling”, Tata McGraw Hill, New Delhi.
6) Agor R, 1991. "Advance Surveying" Khanna Publishers, New Delhi.
7) Venkataramiah C, 2011. "A Text Book of Surveying" University Press, Hyderabad.
8) Alfred Leick , 2003. “GPS Satellite Surveying”, Wiley.
9) Chandra A.M and Ghosh S.K, 2015. “Remote sensing and Geographical Information System”, Alpha Science International Ltd.
10) Bhatta.B, 2011. “Remote Sensing & GIS”, Oxford University Press.
11) Burrough P.A, Mcdonnel R.A and Lloyd C.D, 2015. “Principles of Geographical Information System”, Oxford University Press.
12) Satheesh Gopi, R.Sathikumar and N. Madhu, 2017. “Advanced Surveying -Total Station, GIS and Remote Sensing”, Pearson publication.

CEPC-205 Concrete Technology 3 0 0 3

Course Objectives

- To provide awareness regarding concrete as a structural material.
- To make students knowledgeable about the materials used to make concrete; including their sources, production and properties.
- To provide knowledge regarding designing of normal concrete mixes.
- To make students aware of understanding of various properties of concrete in fresh and harden state.

Course Syllabus

Introduction: Concrete as a Structural material, constituent materials of concrete.

Cement: Types of cements, basic chemistry, heat of hydration, Testing of cement: Fineness, consistency, setting times, strength, types of Portland cements, expansive cements, pozzolanas.

Aggregates: Classification of aggregates, Mechanical properties: Bond, strength, toughness, hardness, physical Properties, Specific Gravity, Bulk density, porosity and absorption, Moisture content, bulking of sand, sieve analysis, fineness modulus, grading of aggregate, maximum aggregate size.

Mix Design: Factors to be considered: water/cement ratio, durability, workability, cement and aggregate content, Design of mix by IS Code Method.

Physical Properties of Fresh Concrete: Workability: factors affecting, methods of determination of workability, Density of fresh concrete.

Mixing, Handling, Placing & compaction of concrete: Mixers, mixing time, ready mixed concrete, pumped concrete, vibration of concrete, internal & external vibrators, re-vibration, shotcrete.

Strength of concrete: Porosity, Gel/space ratio, Total voids in concrete, factors affecting strength: Water/cement ratio, relation between tensile & compressive strengths; bond to reinforcement.

Permeability and Durability: Permeability, sulphate attack, action of frost, frost resistance concrete.

Course outcomes

- Introduction of concrete as a structural material.
- Describe the materials used to make concrete; including their sources, production and properties.
- Knowledge of designing of normal concrete mixes.
- An understanding of various properties of concrete in fresh and harden state.

Text and Reference Books:

1. Neville A M and Brookes J J, “Concrete Technology” Pearson Publishers, New Delhi,1994.
2. Neville A M, “Properties of Concrete” Pearson Publishers, New Delhi, 2004.
3. Gambhir M L, “Concrete Technology” Tata McGraw Hill, New Delhi, 1995.
4. Shetty M S, “Concrete Technology” S. Chand & Company, New Delhi, 2002.
5. Mehta P K,“Microstructure of Concrete” Indian Concrete Institute and ACC, Bombay, 1997.

CEPC-207 **Strength of Material** **3 0 0 3**

Course Objectives:

- To provide the basic concepts and principles of strength of materials.
- To analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
- To give an ability to calculate stresses and deformations of objects under external loadings.
- To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.

Course Syllabus:

Simple stresses and strains: Concept of stress and strain: St. Venants principle of stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stresses and strains in bars subjected to axial loading, Modulus of elasticity, stress produced in compound bars subject to axial loading, Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound walls.

Compound stresses and strains: Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications, Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain, Relationship between elastic constants.

Bending moment and shear force diagrams: Bending moment and shear force diagrams, S F and B M definitions. BM and SF diagrams for cantilevers, Simply supported and fixed beams with or without overhangs and calculation of maximum BM and SF and the point of contra-flexure under: Concentrated loads, Uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Theory of bending stresses: Assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular and channel sections, composite/fletched beams, bending and shear stresses in composite beams.

Torsion: Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts torsional rigidity, combined torsion and bending of circular shafts principal stress and maximum shear stresses under combined loading of bending and torsion, analysis of close-coiled-helical springs.

Thin cylinders and spheres: Derivation of formulae and calculations of hoop stress longitudinal stress in a cylinder, and sphere subjected to internal pressures increase in Diameter and volume.

Columns and struts: Columns under uni-axial load, Buckling of Columns, Slenderness ratio and conditions. Derivations of Euler's formula for elastic buckling load, equivalent length, Rankine Gordon's empirical formula.

Strain energy: Energy of dilation and distortion, resilience stress due to suddenly applied loads, Castigliano's theorem, Maxwell's theorem of reciprocal deflection.

Theories of Failure: Maximum principal stress theory, maximum shear stress, theory, maximum strain energy theory, maximum shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.

Course outcomes:

- Develop an understanding of the concepts of stress and strain and their use in the analysis and design of structures.
- Ability to draw bending moment and shear force diagrams.
- Calculate stresses for axial, torsion, bending, combined bending and axial stress.
- An understanding of the behavior of columns and struts under axial loading.
- Knowledge of different theories of failure.

Text and Reference Books:

1. Pytel A H and Singer F L, "Strength of Materials", 4th Edition, Harper Collins, New Delhi, 1987.
2. Beer P F and Johnston (Jr) E R, "Mechanics of Materials" SI Version, Tata McGraw Hill, India, 2001.
3. Timoshenko S P and Young D H, "Elements of Strength of Materials", 5th Edition, East West Press, New Dlehi, 1984.
4. Bedi D S, "Strength of Materials", 3rd Edition, Khanna Publishing Company 3rd Edition, New Delhi, 2000.
5. Jindal U C, "Introduction to Strength of Materials", Galgotia Publsihing Private Limited 3rd Edition, New Delhi, 2001.

CEPC-209	**Building Construction**	**2 0 0 2**

Course Objectives

- To make students understandable about the different terms used in brick masonry.
- To share knowledge of different components of building and method of construction.
- To make students aware about the different types of slopping roofs.

Course Syllabus

Brick Masonry: Definitions of various terms used, bond – definition, need and scope, type of bonds – Stretcher bond, Header bond, English bond and Flemish bonds, their merits and demerits.

Stone Masonry: Rubble and ashlars work.

Hollow block Masonry: Hollow cement concrete block masonry and hollow clay block masonry.

Walls: Types (i) load bearing and (ii) Non-load bearing walls, Thickness considerations.

Damp Proofing: Causes and ill – effects, preventive measures

Arches and Lintels: Definitions of various terms used in arches, Types – Flat, segmental, semi – circular and Horse – shoe, brick and stone arches, types of lintels, their merits and demerits.

Floors: Constituents, various types of floors commonly used and their suitability for different buildings, constructional details of concrete and terrazzo floors.

Doors and Windows: Location and sizes, types of Doors and windows, Method of fixing door and window frame in walls, ventilators.

Sloping roofs: Definitions of terms used, wooden trusses – king post and queen post truss, steel trusses – fink, fan and north light truss roofs, Jack arch roofs.

Stairs and Staircases: Definition of terms used, Essential requirements, proportioning of steps, types – straight flight, quarter turn, half turn and spiral staircases, ramps, escalators and lifts.

- Footings-types and details

Miscellaneous topics (to be covered briefly): Plastering and Pointing. White washing, color washing, distempering and painting, Scaffolding, underpinning and shoring, Building Bye-laws.

Course outcomes

- To understand the different terms used in brick masonry
- Knowledge of different components of building and method of construction.
- Understand the different types of slopping roofs.

Text and Reference Books:

1. Rangwala S C, “Engineering materials” Charotar Publishing House, Anand, 2000.
2. Bindra & Arora, “Building Construction” Dhanpat Rai Publications (P) Ltd, New Delhi, 2003.
3. Sinha S K and Jha J, “Building Construction” Khanna Publishers, New Delhi, 2001.
4. Rangawala S C, “Building Construction” Charotar Publishing House, Anand, 1993.
5. Ghose D N, “Materials of Construction” Tata McGraw Hill, New Delhi, 2003.

CEPC-211 **Water Supply Engineering** **3 1 0 4**

Course Objectives

- To make the students learn about technical aspects of drinking water treatment and distribution in an integrated way.
- To make the students pay attention to the choice of technologies and tools for water supply, ranging from low cost to advanced options.

Course Content

Public Water Supply: Beneficial uses of water, water demand, per capita demand, variation in demand, causes detection and prevention of wastage of water, population forecasting.

Sources of Water Supply: Surface and underground sources, relation and development of source in r/o quality and quantity of water, development of wells. Storage reservoir balancing and service storage, capacity determination by mass curves method. Intake and transmission system: distribution systems: network design. Hydrology principles, zones of under-ground water.

Quality and Examination of Water: Necessity for examination of water impurities in water. Sampling of water, physical, chemical & bacteriological quality for domestic water supply. Drinking water quality standards and criteria.

Water Supply and Drainage of Buildings: System of water supply house connections, metering, internal distribution, sanitary fittings, pipe joints, different types of pipes and pipes materials.

Water Treatment: Unit operations in water treatment, screening, plain sedimentation tank and its theory, sedimentation, aided with coagulation, design of sedimentation tank, flocculation sand filtration, rapid gravity filter, pressure filters, disinfections; Necessary; requirements of a disinfectant, methods, of disinfecting, different practices of chlorination.

Miscellaneous Methods of Water Treatment: Aerial colour, odors & Taster from water, control, removal of iron & manganese from water softening processes, base exchange process, swimming pool water treatment.

Course outcomes

The student will be able to:

- Identify different types of water demands and select suitable source of water.
- Predict future population and estimate future water demands.
- Demonstrate a firm understanding of various water quality parameters.
- Design different water treatment units to meet the drinking water quality standards and criteria.
- Plan and design the pumping stations and pipe network.

- Design low cost water treatment techniques in the rural areas.

Text and Reference Books:

1. Garg, S.K., 2003. Water Supply Engineering Vol. I, Khanna Publishers, New Delhi.
2. Raju, B.S.N., 1997. Waste and Wastewater, Tata McGraw Hill, New Delhi.
3. Peavy, H.S. and Rowe, D.R., 2003. Environmental Engineerin, McGraw Hill, New Delhi.
4. Birdie, G.S., 2003. Water Supply & Sanitary Engineering, Dhanpat Rai Publications, New Delhi.

CEPC-221 Highway and Traffic Engineering Laboratory 0 0 2 2

Course Objectives

- At the end of the course the student wills possess the knowledge about test on aggregate and bitumen which used in the construction of pavements.
- Able to do the mix design of flexible pavement.

List of experiments

1. Aggregate crushing value test.
2. Aggregate attrition test.
3. Impact value test.
4. Abrasion test (Dorry’s & Los Angeles)
5. Soundness test.
6. Flakiness test.
7. Water absorption & specific gravity test.
8. Laboratory C. B. R. test.
9. North Dakota cone test.
10. Penetration test on bitumen.
11. Softening point test for bitumen.
12. Ductility test.
13. Specific gravity Test.
14. Viscosity test.

15. Flash point and fire point test.

16. Marshall Stability test.

Course outcomes

- Understood different type of aggregate and bitumen test.
- Able to use transportation equipment in laboratory to characterizes the aggregate and bitumen properties.
- Able to do the mix design of flexible pavement

CEPC-223 Concrete Technology Lab 0 0 2 2

Course Objectives

- To determine various properties of cement experimentally
- To determine specific gravity and water absorption of fine and coarse aggregates.
- To perform various test of fresh and harden concrete.
- To carry out the test procedure of compressive test and flexure test.

Course Syllabus

Standard Consistency of cement.

Initial and final setting time of cement.

Soundness of cement.

Specific Gravity of Cement.

Compressive Strength of Cement.

Water absorption and Specific Gravity of Fine aggregates.

Water absorption and Specific Gravity of Coarse aggregates.

Workability of Concrete by Slump cone method.

Workability of Concrete by Compaction Factor method.

Workability of Concrete by Vee-Bee consistometer

Compressive and Flexural Strength of concrete.

Course outcomes

- Determination of various properties of cement experimentally

- Determination of specific gravity and water absorption of fine and coarse aggregates.
- Various test of fresh and harden concrete.
- Carry out the test procedure of compressive test and flexure test

CEPC-225 **Surveying Laboratory** **0 0 2 2**

Course Objectives

- At the end of the course the student wills possess the knowledge about Chain surveying, Compass surveying, Plane table surveying, Levelling, Theodolite, Hydrographic surveying and Engineering surveys.
- Able to use GPS and nautical sextant for measurement.

1. To range a line between two stations.
2. Plotting of details in chain survey.
3. Plotting of traverse with a compass.
4. To determine the reduced levels of stations by height of instrument and rise and fall method.
5. Plotting of details using plane table by method of intersection and method of radiation.
6. Temporary and permanent adjustments of a Theodolite.
7. Measurement of horizontal angles using a Theodolite by method of repetition and method of reiteration.
8. Traverse adjustment using Gales' traverse table.
9. Total station
10. Study and use of nautical sextant and measurement of horizontal angles
11. Plotting of river cross-section by hydrographic surveying
12. Solution to three point problem by analytical method

Course outcomes

- Understood working of different type of surveying equipment.
- Able to use surveying equipment in field for measurement of distance, direction and elevation.

Able to adjust the traverse and calculation of coordinates i.e., latitude and departures.

FOURTH SEMESTER

HMCI-304 Human Resource Management and Industrial Relations 3 0 0 3

Human resources are the most important resources of any organization without which other resources are meaningless. In many industries, human resources provide sustainable competitive advantage. In knowledge economy and information age, their importance has increased than ever before. In this perspective, the course in human resource management is being offered with following objectives:

Course Objectives

1. To learn about basic understanding about human resources, their importance and their management.
2. To understand the key elements of human resource management.
3. To understand the key and emerging issues of human resource management in the changing business scenario.

Course Outcomes

The students would be able to understand the basic framework and dimensions of human resource management. The students would be able to understand how human resources are required to be managed differently from all other resources. The students would also learn how human resources can be better synchronized thorough systemic thinking to give overall synergetic outcomes and serendipitous results.

Outline of the course

Meaning and nature of human resource management (HRM), line and staff aspects of HRM, trends shaping HRM, operating and managerial functions of HRM, job analysis, personnel planning, recruitment, selection, talent management, performance appraisal, training and development, employee retention, career development and management, compensation and financial incentives, benefits and services, managing employee relations, ethics, employee rights and disciplines, labour relations and collective bargaining, industrial dispute act, employee health, safety and welfare, factory act, HR as a profit centre, Green HRM, HR scorecard, managing diversity and global HR resources.

Books Recommended:

1. Gary Dessler, Human Resource Management, 15th Edition, Pearson.
2. George W Bohlander and Scott A Snell, Principles of Human Resource Management, Cengage (2016).
3. C.B. Mamoria and VSP Rao, Personnel Management, 13th Edition, Himalaya Publication.
4. Edwin B Flippo, Personnel Management, 6th Edition, Tata McGraw Hill Education.

MACI-203 **Numerical Methods** **3 1 0 4**

Course Objectives:

To make students ware about the mathematical problems arising in engineering.

Course Syllabus:

Roots of algebraic and transcendental equations, Bisection method, Regula-Falsi method, Newton-Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of simultaneous algebric equations, matrix inversion and eigen-value problems, triangularisation method, Jacobi's and Gauss-Siedel iteration method, partition method for matrix inversion, power method for largest eigen-value and Jacobi's method for finding all eigen-values.

Finite differences, interpolation and numerical differentiation, forward, backward and central differences, Newton's forward, backward and divided difference interpolation formulas, Lagrange's interpolation formula, Stirling's and Bessel's central difference interpolation formulas, numerical differentiation using Newton's forward and backward difference formulas and numerical differentiation using Stirling's and Bessel's central difference interpolation formulas.

Numerical integration, Trapezoidal rule, Simpson's one-third rule and numerical double integration using Trapezoidal rule and Simpson's one-third rule.

Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods for ordinary differential equations, simultaneous first order differential equations and second order differential equations.

Boundary value problems, finite difference methods for boundary value problems.

Partial differential equations, finite difference methods for elliptic, parabolic and hyperbolic equations.

BOOKS RECOMMENDED:

1. S S Sastry, Introductionary Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt.Ltd., New Delhi, India-1999.

2. S C Chapra and R P Canale, Numerical Methods for Engineers, 2nd edition, McGraw Hill Book Company, Singapore 1990.

3. Grewal B S, "Numerical Methods", Khanna Publishers, Delhi.

After studying this course the students will be able to solve the numerical problems which arises in engineering. Students will also be able to get solution to their research problems.

CEPC-202 Structural Analysis-I 3 1 0 4

Course Objectives

- Ability to idealize and analyze statically determinate and indeterminate structures.
- Familiarity with structural analysis software.
- Familiarity with professional and contemporary issues.
- To introduce the students to concept of global structural stability, theory of structural analysis, and methods in structural analysis.

Course Syllabus

Introduction: Need of analysis, techniques of structural idealization, basic tools of analysis, reactions in structure, notations and sign conventions, free – body diagrams, static determinacy, stability of structures, principle of superposition, loads on structures.

Plane Trusses: Introduction, member arrangement in a truss, stability and determinacy, roof and bridge trusses, analysis of trusses, notations and sign conventions, equations of condition, zero load test, classification of trusses.

Deflection of Beams: Introduction, direct integration method, moment – area method, conjugate beam method, Principle of virtual work, unit load method, Betti's law, Maxwell's law, Castigliano's theorem.

Combined Bending and Axial Loads: Introduction, limit of eccentricity for no tension in the section, core of the section, middle third rule, wind pressure on chimneys, forces on dams.

Rolling Loads Introduction to rolling loads and influence lines, Determination of shear force, bending moment at a section and absolute shear force and bending moment due to single point load, uniformly distributed load, several point loads etc.

Influence lines: Introduction, moving loads, influence lines, influence lines for reactions, shear force and bending moment, influence lines for beams, girders with floor beams, trusses and arches, absolute maximum B. M. & S. F, Muller Breslau Principle

Arches: Introduction, curved beams, arch versus a beam, three hinged arch, moment, shears and normal thrust in three hinged arches

Cables and Suspension Bridges: Introduction, shape of a loaded cable, cable carrying point loads and UDL, cables with ends at different level, cable subjected to temperature stresses, suspension bridge with two hinged and three hinged stiffening girders, influence lines.

Statically determinate space Trusses:

Concurrent forces in space, moment of force, constraint of point in space, tension coefficient method, simple space trusses, method of sections.

Course outcomes

- Understand the need of analysis, techniques of structural idealization, basic tools of analysis.
- Analysis of statically determinate structural systems.
- Concept of deflection of beams.
- Understand the concept of rolling loads and/or reactions, support displacements and on the structures.
- Analysis of statically determinate plane and space trusses.
- Able to draw the influence lines of beams, trusses, girders and arches.

Text and Reference Books:

1. Utku S, Norris C H and Wilbur J B, "Elementary Structural Analysis, McGraw Hill, New York, 1990.
2. Jain A K, "Elementary Structural Analysis" Nem Chand & Brothers, Roorkee, 1990.
3. Reddy C S , "Basic Structural Analysis" Tata McGraw Hill, New Delhi, 2003.
4. Hibbeler C, "Structural Analysis" Pearson Publishers, New Delhi, 2002.
5. Punmia B C, Jain A K and Jain A K "Theory of Structures" Luxmi Publications, 2000.

CEPC-204 Wastewater Engineering 3 1 0 4

Course Objectives

- To make the students learn about wastewater network
- To make the students aware of the various terms used in wastewater treatment.

- To make the students learn the basics of wastewater treatment.

Course Content

Introduction: Terms & definitions, systems of sanitation and their merits and demerits, system of sewerage, choice of sewerage system and suitability to Indian conditions. Design & planning of a sewage system.

Design of Sewers: Quantity of sanitary and storm sewage flow, forms of sewers, conditions of flow in sewers, sewers of equivalent section, self cleansing and limiting velocity, hydraulic formulas for flow of sewerage in sewers and their design.

Construction & Maintenance of Sewers: Sewer appurtenances, Materials for sewers, laying of sewers, joints in sewers, testing of sewers pipes, Maintenance operations and precaution before entering a sewer. Excavating Trenches.

House Drainage: Principles of house drainage, traps, Inspection chamber Indian and European type W. C., Flushing Cisterns soil waste and anti-siphonage pipes, plumbing systems.

Characteristics & Testing of Sewage: Composition of sewage, sampling, physical & chemical analysis of sewerage, biological decomposition of sewage, kinetics of organic waste stabilization. Populating equivalent & relative stability.

Treatment of Sewage: Unit processes of waste water treatment, screens, grit chambers, detritus tank, skimming tank, grease traps, sedimentation, chemical treatment, aerobic biological treatment, trickling filter (LRTF & HRTF), activated sludge processes, anaerobic treatment, units-sludge digesters and biogas plants.

Low cost waste water treatment units: Oxidations Ponds, Lagoons, ditches, septic tanks and imhoff tanks, theory, design, advantages & disadvantages.

Sewage Disposal: Dilution, self-purification of streams, oxygen deficiency of polluted streams, oxygen sag serve, deoxygenation and deoxy- genation. Dilution in seawater, disposal by land treatment. Effluent irrigation and sewage farming. Sickness and its preventive measures.

Course outcomes

The student will be able to:

- Demonstrate a firm understanding of various sewerage systems and their suitability.
- Design sewer and drainage systems layout for communities.
- Evaluate the waste water characteristics to determine the degree of treatment required.
- Explain the physical, chemical and biological techniques of wastewater treatment.
- Compare the applicability of treatment technologies under different conditions.
- Design the treatment units and assess the efficacy of an entire treatment system.

- Ability to make decisions regarding the treatment plant site selection, operation and maintenance and the need of advanced treatment.

Text and Reference Books:

1. Garg, S.K., 2003. Water Supply Engineering Vol. I, Khanna Publishers, New Delhi.
2. Birdie, G.S., 2003. Water Supply & Sanitary Engineering, Dhanpat Rai Publications, New Delhi.
3. Peavy, H.S. and Rowe, D.R., 2003. Environmental Engineerin, McGraw Hill, New Delhi.
4. Fair, G.M. and Geyer, J.C., 2002. Water Supply & Waster Water Disposal.
5. Nathanson, J.A., 1999. Basic Environmental Technology, Prentice Hall of India, New Delhi.

CEPC-206 Earth Sciences 3 0 0 3

Course Objectives

- To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering.
- To provide the students an illustration of the significance of the Civil Engineering Profession in satisfying societal needs.

Course Syllabus

General Geology: Divisions of geology, Importance of Engineering Geology versus geology applied to Civil Engineering practices. Weathering, definition types and effect. Geological works of rivers, wind, glaciers as agents of erosion, transportation and deposition, resulting features and engineering importance.

Rocks and Minerals: Minerals, their identification and physical properties of minerals, igneous, sedimentary and metamorphic rocks, their formation and structures. Classification of rocks for engineering purpose. Rock quality designation (RQD).

Structural Geology: Brief idea about stratification, apparent dip, true dip, strike and unconformities.

Folds: Definition, parts of a fold, classification, causes relation to engineering operations.

Faults: Definition, parts of a fault, classification cause relation to engineering purposes.

Joints: Definition, attitude, joint set, joint systems, classification in relation to engineering operations.

Engineering Geology: Geological considerations in the Engineering Projects like tunnels, highways, foundations, dams, and reservoirs. Earthquake.Definition, terminology, earthquake waves, intensity, recording of earthquake, seismic zones in India, factors to be considered and methods in earthquake proof construction.

Earth movements: Landslides and land subsidence, elementary idea about classifications, factors causing landslides and land subsidence, preventive measures like relating walls, slope treatment, chemical stabilization and drainage control.

Engineering Properties of Rocks and Laboratory Measurement: Uniaxial compression tests, tensile tests, permeability test, shear tests, effect of size and shape of specimen and rate of testing. Confining pressure, stress strain curves of typical rocks. Strength of intact and fissured rocks, effect of anisotropy, influence of effect of pore fluid type instauration and temperature.

In-situ determination of Engineering Properties of Rock Masses: Necessity of in-situ test, uniaxial load tests in tunnels and open excavation, cable tests, flat jack test, shear test, pressure tunnel test. Simple methods of determining in-situ stresses, bore hole over coring technique-bore hole deformation gauges.

Improvement in Properties of Rock Masses: Pressure grouting for dams and tunnels, rock reinforcement, rock bolting.

Course outcomes

- Understand the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- Knowledge of different types of rocks and minerals and their physical properties.
- Knowledge of in situ determination of engineering properties of rock masses.
- Understand the concepts of folds and faults, their classification and relation to engineering purposes.

Text and Reference Books:

1. Goodman R E, “Introduction to Rock Mechanics”, John Wiley & Sons, New York, 1989.
2. Jaguer J C and Cook N G W, “Foundational of Rock Mechanics” 3rd ed., Chapman & Hall London, 1979.
3. Lama R D and Vutukuri V S with Saluja S S, “Handbook on Mechanical Properties of Rocks” Vols. I to IV, Trans Tech Publications, Rockport, MA.
4. Arora D S, “A Text Book of Geology”, Mahindra Capital Publishers, Chandigarh, 1988.
5. Singh P, “Engineering and General Geology” S. K. Kataria and Sons, New Delhi, 1992.

CEPC-208 Fluid Mechanics 3 1 0 4

Course Objectives:

- To inculcate the understanding of fluid and it behavior.
- To provide the students an illustration of the significance of the fluid in Civil Engineering Profession.

- To illustrate the fluid analysis over different bodies and medium

Course Syllabus:

Laminar Flow: Navier-stokes equations in cartesian coordinates (no derivation), meaning of terms, flow between parallel plates, stokes law, Flow through porous media, Transition from laminar to turbulent flow.

Boundary Layer Analysis: Assumptions and concept of boundary layer theory, Boundary layer thickness, displacement momentum & Energy thickness, laminar and Turbulent boundary layers on a flat plate, Laminar sub-layer, smooth and rough boundaries, Local and average friction coefficients, Separation and control.

Turbulent Flow: Definition of turbulence, scale and intensity, Effects of turbulent flow in pipes, Equation for velocity distribution in smooth and rough pipes (no derivation), Resistance diagram.

Flow past immersed bodies: Drag and lift, deformation Drag and pressure drag, Drag on a sphere, cylinder and Airfoil, lift-Magnus Effect and circulation, lift on a circular cylinder.

Uniform flow in open Channels: Flow classifications, basic resistance, Equation for open channel flow, Chezy, Manning, Bazin and kutter formulae, Variation of roughness coefficient, conveyance and normal depth, Velocity distribution, Most efficient flow sections- Rectangular, trapezoidal and circular.

Energy and Momentum Principles and Critical Flow: Energy and specific Energy in an open channel; critical depth for rectangular and trapezoidal channels. Alternate depths, applications of specific Energy to transitions and broad crested weirs. Momentum and specific force in open channel flow.

Gradually Varied Flow: Differential Equation of water surface profile; limitation, properties and classification of water and surface profiles with examples. Computation of water surface profile by graphical, numerical and analytical approaches.

Hydraulic Jump and Surges: Theory of Jump, Elements of jump in a rectangular channel, length and height of jump, location of jump, Energy dissipation and other uses. Surge as a moving hydraulic jump. Positive and negative surges.

Course outcomes:

- An understanding of fluid mechanics fundamentals, including concepts different types of flows and their principles.
- Knowledge of laminar and turbulent boundary layer fundamentals.
- An understanding of energy and momentum principles.
- Computation of water surface profile by graphical, numerical and analytical approaches.

Text and Reference Books:

1. Massey B S, “Mechanics of Fluids” ,ELBS, Van Nostrand Reinhold Co. Ltd., U. K, 1998.
2. Streeter V L, Wylie E B and Bedford K W, “Fluid Mechanics” McGraw Hill, New York, 2001.
3. Kumar D S, “Fluid Mechanics”, S. K. Kataria & Sons Publishers, New Delhi, 1998.

4. Subramanya K, “Theory and Application of Fluid Mechanics” Tata McGraw Hill, New Delhi 2001.

5. White F M, “Fluid Mechanics” McGraw Hill, New York, 1997.

CEPC-222 Fluid Mechanics Lab 0 0 2 2

Course Objectives

- To visualize the flow in different medium.
- To understand the flow properties and behavior.
- To demonstrate the flow behavior in Civil Engineering Profession for satisfying societal needs.

Course Syllabus

1. To draw flow net from Hele-Shaw Experiment (flow past a Circular cylinder)
2. To study the transition from laminar to turbulent flow in a pipe.
3. Verification of Stokes law
4. To draw flow net by electrical analogy method
5. Determination of Elements of Hydraulic Jump.
6. Discharge & flow profile of a broad crested weir.
7. To determine the viscosity of a given liquid by capillary-tube-viscometer.
8. To determine Manning’s co-efficient of roughness for the bed of a given flume.
9. To measure the velocity distribution in a rectangular flume and to determine the energy and momentum correction factors.
10. To calibrate a current meter.
11. To study the flow over a hump placed in an open channel.
12. Demonstration of surges in an open channel.
13. Demonstration of forced vortex.

Course outcomes

- To study the transition from laminar to turbulent flow in a pipe.
- Determination of surges in open channels.
- Demonstration of forced vortex flow.
- Determination of various coefficients experimentally.
- To draw flow net by electrical analogy method.

CEPC-224 Structural Analysis-I Laboratory 0 0 2 2

Course Objectives

- Able to analyze the determinate structure and its reaction diagram.
- Able to draw the influence line diagram for rolling loads.
- Able to interpret the various methods of structural displacements.

Course Syllabus

1. To determine the flexural rigidity of a given beam.
2. To verify the moment area theorems for slope and deflection of a given beam.
3. **Deflection of a simply supported beam and verification of Clark-Maxwell theorem.**
4. Experiments on curved beam.
5. Deflection of statically determinate pin jointed truss.
6. Study of behaviour of columns and struts with different end conditions.
7. Experiment on three-hinged arch.
8. Experiment on two-hinged arch.
9. Deflection of a fixed beam and influence line for reactions.
10. Deflection studies for a continuous beam and influence line for reactions.
11. Unsymmetrical bending of a cantilever beam.

Course outcomes

- To carry out different experiment on beams and verify the important theorems.
- To conduct an experiment on curved beam.
- To study the behaviour of columns and struts with different end conditions.
- To analyse two hinged and three hinged arches.

CEPC-226 Wastewater Engineering Laboratory 0 0 2 2

Course Objectives

- To impart practical knowledge of water chemistry to the students
- To make students familiar with laboratory procedures for water and wastewater

Course Content

List of Experiments

1. Determination of Total, suspended, dissolved volatile & fixed residue in a sewage/water sample.
2. Determination of Turbidity.
3. Estimation of the pH-Value.
4. Determination of the carbonate, Bicarbonate and Hydroxide Alkalinity.
5. Determination of the type and Extend of Acidity.
6. Estimation of the Hardness of water (EDTA Method).
7. Estimation of the chloride concentration.
8. Determination of the Dissolved oxygen and percentage saturation.
9. Determination of Biochemical Oxygen Demand BOD of wastewater.
10. Estimation of Chemical Oxygen Demand. (COD)

Course Outcomes

The students will be able to

- To conduct experiments as per standard methods of sampling and analysis.
- To demonstrate the expertise to characterize water and wastewater samples.
- To understand the importance of laboratory analysis as a controlling factor in the treatment of water and wastewater.

Text and Reference Books:

1. Sawyer,C.N., McCarty, P.L. and Parkin,G.F., (2002). Chemistry for Environmental Engineering and Science. 5th edition, McGraw-Hill Publishing Company.
2. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2012.

CEPC-230 **Survey Camp** **0 0 0 2**

The students will undergo Survey Camp (2-3 weeks) during the summer vacation in a hill station.

FIFTH SEMESTER

CEPC-301 **Design of Concrete Structures-I** **3 1 0 4**

Course Objectives

- Be able to perform analysis and design of reinforced concrete members.
- Be able to identify and interpret the appropriate relevant industry design codes.
- To become familiar with professional and contemporary issues in the design and fabrication of reinforced concrete members.
- To be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.

Course Syllabus

Introduction: Plain and Reinforced Concrete, Objectives of design. Structural systems. Introduction to design philosophies.

Analysis of Beams: Working Stress Method, Assumptions made in theory of reinforced concrete construction, moment of resistance of singly, doubly reinforced and flanged beams.

Limit State Method: Assumptions in analysis, Analysis of singly and doubly reinforced rectangular sections, Analysis of singly reinforced flanged sections.

Design of Beams for flexure: Codal provisions for design as per IS 456:2000 according to working stress and limit state method, Design of singly and doubly reinforced sections, Design of flanged sections.

Design for Shear, Bond & Torsion: Shear Stresses in homogeneous rectangular beams, critical sections, design shear strength of plain concrete, Design of shear reinforcement, Bond stress, Anchorage development length, bond failure & bond strength,

Introduction to torsion in R. C. C. beams, General behaviour in torsion, Design of sections subjected to torsion, shear and flexure.

Design of Slabs: One-Way and two-way slabs. Design of slab sections using IS method. Introduction to flat slabs.

Design of Continuous beams and slabs: Analysis of continuous systems General guidelines & Codal provisions design and detailed drawings of continuous beams and slabs.

Design of columns: Classification and effective length of columns, codal requirements, Analysis and design of sections subjected to axial loading and axial loading combined with bending moment.

Design of Isolated Footings: Types of footings, soil pressure under footings, General design considerations and Codal provisions. Design of isolated, square, rectangular and circular footings. Design of footings subjected to eccentric loads.

Staircases: Types of staircases, loads on stairs, Design of different types of staircases.

Course outcomes

- To learn about the reinforced concrete, its properties.
- To learn about different design philosophies for design of concrete structures.
- To carry out analysis of beams.
- Understand the limit state method of design of rcc members.
- Knowledge of design provisions given in Indian standard code.
- To design the various members like beams, slabs, columns, footings etc with limit state design method.

Text and Reference Books:

1. Pillai U. and Menon D., "Reinforced Concrete Design" Tata McGraw Hill, New Delhi 2003.
2. Jain A.K., "Limit State Design of R. C. C. Structures" Nem Chand & Sons, Roorkee 2002.
3. Varghese "Limit State Design of Reinforced Concrete" Prentice Hall of India, New Delhi 2003.
4. Dayaratnam P., "Design of Reinforced Concrete" Oxford & IBH Publishers, New Delhi 2002.
5. Chandra R., "Limit State Design of Reinforced Concrete" Standard Book House, New Delhi 2002.

CEPC-303 Railway, Airport and Harbour engineering 3 0 0 3

Course Objectives

- Students should be able to relate their understanding of the railroad industry, history, and principal components.

- Finding out the traffic load analyzing them and designing transportation systems.

Course Syllabus

Railway Introduction: History of development of Railways, Permanent Way, Requirement of ideal permanent way, cross-sections of single and double tracks in embankment and cutting.

Rail & sleepers: Component Parts of RailwayTrack, Gauges, Resistances to Traction and Stresses in Track, Various Resistances and Their Evaluation, Hauling Capacity and Tractive Effort, Stresses in Rail, Sleepers, Coning of Wheels, Creep, Wear, Joints in Rails, Sleeper Types, Rail Fittings and Fixtures: welding, rail to rail connection, rail to sleeper connection, bearing plates and chairs

Geometric design of railway: Geometric Design, Track Alignment, Horizontal Curves, Super Elevation, Equilibrium Cant and Cant Deficiency, Transition Curves, Vertical Curves-Gradients and Grade Compensation

Points and Crossing: Simple types currently in use: points and crossing terminology, layout plans of simple cross over, turnouts, diamond crossing, Geometric design of a simple turn out design of crossings & switches.

Signaling and Interlocking: Objects of signaling, types of signals, Interlocking and devices used in interlocking.

Airport Introduction: Airport classification, classification of flying activities. Characteristics & airport size.

Airport Planning: Types of runway patterns, Running layout effect of metrological conditions, wind rose, specifications for runway clearances and other airport utilities, Airport Site Selection, Airport Obstructions, Zoning, Classification of Obstructions, Imaginary Surfaces, Approach Zone and Turning Zones,

Runway & Taxiway Design: Airport Capacity, Loading Apron, Service Hanger, Taxiway Design, Introduction to Airport Pavement Design.

Docks and Harbours: Definition, location & layout of docks, classification of docks Simple description, frequent dealing with natural and artificial harbour, their classification & requirement, action of wind, water, tides and lateral drift on harbour structures.

Courseoutcomes

- Knowledge of history of development of railways.
- Understand the working of different elements of railway track.
- Understand the airport planning for efficient development of airports.
- To get familiar with docks and harbours, their classification and requirement.

Text and Reference Books:

1) Rangawala, S. C., 2002. Railway engineering. Charotar Publishers, Anand.

2) Arora, S. P., and Saxena, S. C., 2001. Railway engineering. Dhanpat Rai Publishers, New Delhi.

3) Khanna, S. K., Arora, M. G. and Jain, S. S., 2002. Airport planning & design. Nem Chand & Bros., Roorkee.

4) Srinivasan, R. and Rangwala, S. C., 1999. Harbours. Charotar Publishers, Anand.

CEPC-305 Soil Mechanics 3 1 0 4

Course Objectives

1. To understand origin of soil, different types.
2. Knowledge of different index properties of soil.
3. Study of classification of fine grained and coarse grained soils.
4. To understand the concept of compaction and consolidation of soil.
5. Understand the shear strength of soil and its engineering importance and application.

Course Syllabus

Basic Concepts: Definition of soil and soil mechanics common soil problem in Civil Engineering field. Principal types of soils. Important properties of very fine soil i. e. adsorbed water, base exchange and soil structure. Characteristics of main clay mineral groups. Basic definitions in soil mechanics. Weight volume relationship physical properties of soils.

Index Properties: Determination of Index properties, classification of coarse grained soils and fine grained soils.

Permeability and seepage: Concept of effective stress principle. Seepage pressure, critical hydraulic gradient and quick sand condition, Phreatic Line. Capillary phenomenon in soil. Darcy's law and its validity seepage velicity. Co-efficient of permeability and its determination average permeability of striated soil mass Factors affecting 'K' and brief discussion.

Compaction: Definition and object of compaction and concept of O.M.C. and zero Air Void Line. Modified proctor test. Factors affecting compaction. Effect of compaction on soil properties and their discussion. Field compaction methods their comparison of performance and relative suitability. Field compactive effort. Field control of compaction by proctor needle.

Consolidation: Definition and object of consolidation difference between compaction and consolidation. Concept of various consolidation characteristics i.e. a_v, m_v and C_v primary and secondary consolidation. Terzaghi's method for one-dimensional consolidation. Consolidation test. Determination of C_v from curve fitting methods. Normally consolidated and over consolidated clays importance of consolidation settlement in the design of structures.

Stress Distribution: Boussinesq's equation for a point load, uniformly loaded circular and rectangular area, pressure distribution diagrams. New marks chart and its construction. Two- to – one method of load distribution. Comparison of Bossinesq and Westerguard analysis for a point load. Limitations of elastic formula.

Shear Strength: Stress analysis of a two - dimensional stress system by Mohr circle. Concept of pole. Coulomb's law of shear strength Coulomb - Mohr strength theory. Relations between principle stresses at failure Shear strength tests. Derivation of Skempton's pore pressure parameters. Stress strain and volume change characteristics of sands.

Course outcomes

- The students will be able to understand the origin of soil and will have the knowledge of different index properties
- They will be able to classify soil and understand the engineering behaviour of soil

Text and Reference Books:

1. Holtz, R.D. and Kovacs, W.D., 1981. An Introduction to Geotechnical Engineering. Prentice Hall.
2. Ranjan, G. and Rao A.S.R., 2000. Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
3. Murthy V N S., 2001. Principles of Soil Mechanics and Foundation Engineering. UBSPD.
4. Das, B.M. 2002. Principles of Geotechnical Engineering. Cengage Pulishers
5. Lambe, T.W. and Whitman, R.V., 2000. Soil Mechanics. John Wiley and Sons
6. Couduto, D.P., 2002. Geotechnical Engineering – Principles and Practices", Prentice Hall of India.

CEPC-307 **Structural Analysis-II** **3 1 0 4**

Course Objectives:

- To understand indeterminate structure and methods of analysis.
- To analysis of indeterminate beams and frames by slope deflection method, moment distribution method, kani's method
- To analysis of indeterminate beams and frames without and with sidesway by using moment distribution method.
- To analysis two hinged arches.
- To understand application of influence line method for indeterminate beams.

Course Syllabus:

Statically Indeterminate Beams and Frames: Introduction, types of supports-reaction components, external redundancy, statically indeterminate beams and frames, degree of redundancy

Fixed and Continuous Beams: Bending moment diagrams for fixed beams with different loadings, effect of sinking of supports, degree of fixity at supports, advantages and disadvantages of fixed beams, continuous beams, Clayperons theorem of three moments, various cases of load and geometry of continuous beams.

Slope Deflection Method: Fundamental equations, Applications to continuous beams and portal frames, side sway in portal frames.

Moment Distribution Method: Basic propositions, stiffness of a member, distribution theorem, carry-over theorem, relative stiffness, distribution factors, applications to continuous beams, portal frames with and without side sway, analysis of multi-storeyed frames, method of substitute frame.

Rotation Contribution method: Basic concepts, rotation factor, and application to continuous beams, portal frames and multistoried frames, story shear.

Approximate methods of Structural Analysis: Portal method, Cantilever Method, Substitute Frame Method.

Strain Energy: General principles, strain energy due to axial loading and bending, law of reciprocal deflections, Castigliano's first theorem, beam deflections using Castigliano's first theorem, minimum strain energy, Castigliano's second theorem, analysis of statically indeterminate beams and portal frames.

Redundant Frames: Order of redundancy, frames with one and two redundant members. Stresses due to lack of fit, the trussed beam, portal frames.

Analysis of two hinged arches

Influence lines for indeterminate Structures: Muller Breslau Principle, Influence lines for shear force, bending moment and reactions in continuous beams, balanced cantilevers and rigid Frames.

Course outcomes:

- Analysis of statically indeterminate beams and frames.

- Understand the concept of slope deflection method and its application to continuous beams and portal frames.
- To analyze the beams and portal frames with different types of method.
- Knowledge of approximate methods of structure analysis.
- To carry out analysis of redundant frames.

Text and Reference Books:

1. Reddy C S, "Basic Structural Analysis" Tata McGraw Hill, New Delhi, 2003.
2. Wang C K, "Intermediate Structural Analysis" McGraw Hill, 1998.
3. Punmia B C, "Theory of Structures" Luxmi Publications, New Delhi, 1996.
4. Sinha N C, "Advanced Theory of Structures" Dhanpat Rai Publications, New Delhi, 2000.
5. Ramamrutham S and Narayan R, "Theory of Structures:" Dhanpat Rai & Sons, New Delhi, 1996.

CEPC-309 Construction Management 3 0 0 3

Course Objectives

- To develop skills in the management and control of construction operations.
- To study the techniques of planning resources and executing them.
- To predict the probability of completion of project and in less time.

Course Syllabus

Introduction: Need of project planning & Management, value Engineering, time value of money, construction schedule activity & event, bar chart, milestone chart, uses & draw backs.

PERT: Construction of PERT network, time estimate & network analysis, forward pass & backward pass, event slack, critical path, data reduction.

CPM: Definitions, network construction, fundamental rules determination of project schedule, activity time estimates, float types, their significance in project control, critical path.

Three phase application of CPM: Planning scheduling & controlling, updating an arrow diagram, time grid diagram, resource scheduling.

Cost analysis & contract: Types of project cost, cost time relationships cost slopes, conducting a crash programme, determining the minimum total cost of a project.

Factor affecting Selection of equipment: Type of equipment, depreciation cost, operating cost, Economic life of equipment, maintenance & repair cost.

Earth Moving Machinery: Tractors & related equipment, bulldozers, scrapers, Power shovels, dragline, hoes etc.

Construction Equipment: Grading / proportioning, batching mixing, types of mixers, concrete pumps, placing & compacting concrete.

Hoisting & Transporting Equipment: Hoists, winches, cranes, belt conveyors, truck etc.

Courseoutcomes

- To understand the need of project planning and management.
- Knowledge of different methods of project planning.
- To perform cost analysis to determine minimum cost of project.
- To make aware with different construction equipment and their working.

Text and Reference Books:

1) Srinath, L. R., 1999. PERT & CPM. Affiliated East-West press (P) Ltd., New Delhi.
2) Modi, P. N., 1995. PERT & CPM, Standard Book House, Delhi.
3) Wiest, J. D., 1997. A management guide to PERT & CPM. Prentice Hall of India (P) Ltd, New Delhi.
4) Peurify, R. L, 1996. Construction, planning equipment & management. McGraw Hill Book company, New Delhi.
5) Sharma, S. C., 1990. Construction equipment & its management. Khanna Publishers, Delhi.

CEPC-311 **Irrigation Engineering** **3 0 0 3**

Course objectives:

- To provide the basics of hydrological cycles and water harvesting
- To understand the type or crops and irrigation methods in India and globe
- To provide the basics of ground water and its uses in irrigation engineering

- To give knowledge of irrigation project report and its preparation

Course Syllabus:

Introduction: Water shed and its management, its relation to hydrologic cycle (in brief), introduction about rain water harvesting and about the present need in Punjab.

Surface water hydrology - Rainfall and its measurement, mean rainfall, runoff; Flow measurements; Infiltration losses

Methods of Irrigation: Advantages and disadvantages of irrigation, water requirements of crops, factors affecting water requirement, consumptive use of water, water depth or delta and crop relation, Duty of water, relation between delta, duty and base period, Soil crop relationship and soil fertility, sprinkler Irrigation – advantages & limitations, Planning and design of springler irrigation, Drip irrigation – advantages & limitations, suitability.

Canal Irrigation: Classifications of canals, canal alignment, Inundation canals, Bandhara irrigation, advantages and disadvantages. Silt theories – Kennedy's theory, Lacey's theory, Drawbacks in Kennedy's & Lacey's theories, comparison of Lacey's and Kennedy's theories, Design of unlined canals based on Kennedy & Lacey's theories, suspended and bed loads.

Lined Canals: Types of lining, selection of type of lining, economics of lining, maintenance of lined canals, silt removal, strengthening of channel banks, measurement of discharge in channels, design of lined canals methods of providing drainage behind lining.

Investigation and preparation of irrigation project: Classification of projects, project preparation investigations, design of works and drawings, concepts of multi purpose projects, Major, medium and minor projects, planning of an irrigation project, economics & financing of irrigation works documentation of project report, Present cutes of water changed by Irrigation Department from cultivation.

Tube Well Irrigation: Types of tube wells strainer type, cavity type and slotted type. Type of strainers, aquiclude, aquifer, porosity, uniformity coefficient, specific yield & specific retention, coefficients of permeability, transmissibility and storage. Yield or discharge of tube well, assumptions, Theim & Dupuit's formulas. Interference of tube wells with canal or adjoining tube wells, optimum capacity. Duty and delta of a tube well. Rehabilitation of tubewells.

Course outcome:

- To understand the concepts of water shed management and its relation to hydrological cycle.
- Knowledge of different methods of irrigation, their advantages and disadvantages.
- Concept of canal irrigation, and various theories for canal designing.
- Study of river training works, its objectives, classification and design of various elements.

Text and Reference Books:

1. Singh Bharat, "Fundamentals of Irrigation Engineering" Nem Chand & Brothers, Roorkee, 1975.

2. Arora K R, “Irrigation Water Power & Water Resources Engineering” Standard Publishers Distributors, Delhi, 2002.
3. Garg S K, “Irrigation Engineering & Hydraulic Structures” Khanna Publishers, Delhi, 1995.
4. Varshney, Gupta & Gupta, “Irrigation Engineering & Hydraulic Structure” Nem Chand & Bros., Roorkee,1982.
5. Asawa G L, “Irrigation Engineering” Wiley Eastern Ltd., New Delhi,1993.
6. Subramanya K, “Engineering Hydrology” Tata McGraw-Hill, New Delhi, 2001.

CEPC-321 Soil Mechanics Laboratory 0 0 2 2

Course Objectives

1. To carry out the visual examination of soil.
2. Determination of different index properties of soil.
3. To carry out hydrometric analysis.
4. To conduct compaction and consolidation test on soils.

List of Experiments

1. Visual Examination of soil samples. Field identification tests. Classification as per IS Code.
2. Determination of water content of soil:
    a. By oven drying method
    b. Pycnometer method
3. Determination of in- situ density by core cutter method and sand replacement method.
4. Determination of Liquid Limit & Plastic Limit by Casagrande apparatus and penetrometer method.
5. Determination of specific gravity of soil solids by pyconometer method.
6. Grain size analysis of given sample of sand and determination of coefficient of uniformity and coefficient of curvature.
7. Hydrometer analysis.

8. Direct shear test on a given soil sample.
9. Unconfined compression test for fine-grained soil.
10. Tri-axial Shear Test.
11. Lab vane shear test
12. Determination of permeability by constant head Methods and variable head method.
13. Compaction test (Proctor) and Modified proctor test. Plot of zero air voids line.
14. Consolidation Test

Course outcomes

- Students will be able to visually examine the soil
- Students will be able to determine Water content, specific gravity, Atterberg's Limits and Gradation of soil
- Students will be able to determine laboratory as well as field compaction
- Students will be able to determine the shear properties (cohesion and angle of friction).

CEPC-323 Hydraulic Structures Drawing 0 0 2 2

Course Objectives

- To make students knowledgeable regarding drawing of weirs, barrages and cross drainage works.
- To make students familiar with drawings of various elements of hydraulic structures including plan, elevation and section views.

Course Syllabus

Drawings (Plan, Elevations and Section) of

Canal Falls

Distributory Regulators

Cross Drainage Works

Design of Weirs

Course outcomes

- Make drawing of weirs and cross drainage works.
- Make drawings of various elements of hydraulic structures including plan, elevation and section views.

CECI-301 Minor Project Phase-I 0 0 2 2

The students will be allotted the minor project in phase – I.

SIXTH SEMESTER

CEPC-302 **Foundation Engineering** **3 1 0 4**

Course Objectives

1. To provide knowledge base on the current practices in foundation engineering to carry out the job of selection, design and construction of foundations.
2. To study the earth pressure theories.
3. To carry out the soil investigation and study of methods involved in it.
4. Understand the significance and determine the load bearing capacity for shallow and deep foundations.
5. To carry out analysis and design of pile foundation and machine foundation.
6. Understand the concepts of stability of slopes.

Course Syllabus

Earth Pressure: Terms and symbols used for a retaining wall. Movement of wall and the lateral earth pressure. Rankine's and Coulomb's theory for lateral earth pressure. Culmann's graphical construction and Rebhan's graphical construction.

Arching in soil and Braced Cuts: Theory of Arching, Braced excavations, Deep cuts in sand, saturated soft to medium clays.

Soil Investigation: Object of soil investigation for new and existing structures. Depth of exploration for different structures. Spacing of bore holes. Methods of soil exploration and relative merits and demerits. standard penetration test, dynamic cone penetration test, static cone penetration test, field vane shear test, large shear box test, field permeability test, Geophysical Tests, Dynamics properties of soil planning of soil exploration programme.

Shallow Foundation: Types of shallow foundations, definitions Terzaghis analysis. Types of failures. Factors affecting bearing capacity. Skemptons equation. B. I. S. recommendations for shape, depth and inclination factors. Plate Load Test and Standard Penetration Test. Contact pressure distribution. Causes of settlement of structures comparison of immediate and consolidation settlement Calculation of settlement by plate load test and Static Cone Penetration Test data. Allowable settlement of various structures according to IS Code. Situation most suitable for provision of rafts. Proportioning of rafts in sand and clays. Various methods of designing raft. Floating foundation.

Types of foundations, selection of type of foundation, basic requirements of a foundation, computation of loads, Design steps.

Pile Foundation : Necessity and uses of piles, classification of piles. Merits and demerits of different types based on composition. Types of pile driving hammers & their comparison. Effect of pile driving on adjacent ground. Use of Engineering news formula and Hiley's formula for determination of allowable load. Pile Load Test, separation of skin friction and point resistance using cyclic pile load test data. Related Numerical problems. Determination of point resistance and frictional resistance of a single pile by static formula. Piles in clay, safe load on a friction and point bearing pile. Pile in sand spacing of piles in a group, factors affecting capacity of a pile group. Efficiency of pile group bearing capacity of a pile group in clay. Settlement of pile groups in clay and sand Negative skin friction.

Stability of Slopes: Necessity, causes of failure of slopes. Stability analysis of infinite and finite slopes in sand and clay. Taylor's stability number and its utility.

Caissons and wells: Major area of use of caissons Advantages and disadvantages of open box and pneumatic caissons. Essential part of a pneumatic caisson. Components of a well.

Machine Foundations: Theory of vibrations, foundations subjected to vibrations, determination of dynamic properties of soil, Dynamic analysis of block foundations.

Course outcomes

- The students will be able to select the correct foundation for the structure, calculate the bearing capacities
- They will be able to determine the stability of slopes, calculate lateral earth pressures

Text and Reference Books:

1. Ranjan, G. and Rao A.S.R., 2000. Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
2. Murthy V N S., 2001. Principles of Soil Mechanics and Foundation Engineering. UBSPD.
3. Das, B.M. 2004. Principles of Foundation Engineering. Cengage Pulishers
4. Couduto, D.P., 2002. Geotechnical Engineering – Principles and Practices", Prentice Hall of India.

CEPC-304 Design of Concrete Structures-II 3 0 0 3

Course Objectives

- To design special reinforced concrete components such as footings, retaining walls, curved beams, domes and water tanks.
- To model and predict the response of reinforced concrete members under axial, flexure and shear loads.
- To have the ability to compose, solve and evaluate the internal forces, the deformations, the stresses and reinforcements in various structures made of special Reinforced Concrete.

Course Syllabus

R. C. C. Footings: Design of combined footings (Trapezoidal and rectangular) Design of Strap footing and raft foundations. Design of piles and pile footings.

Beams curved in plan: Design of semicircular beams supported on three supports. Design of circular beam supported on symmetrically placed columns.

Domes: Introduction to different types of domes and shells. Design of spherical and conical domes. Design of cylindrical shells supported on edge beams.

Retaining Walls: Design of cantilever and counter fort retaining walls. Design of basement walls.

Water Tanks: Introduction, Design of tanks resting on ground, under ground tanks and elevated tanks.

Course outcomes

- Able to design various types of footings with reference to is codes.
- Able to design of special structural elements like, beams curved in plan, domes.
- Able to design of different types of retaining wall.
- Design of different types of water tanks.

Text and Reference Books:

1. Raju N K, "Advanced Design of Structures" Tata McGraw Hill, New Delhi, 2000.
2. Varghese P C, "Advanced Reinforced Concrete Design" Prentice Hall of India, New Delhi, 2001.
3. Dayaratnam, P," Advanced Design of Concrete Structures" Oxford and IBH Publishing Co, Pvt. Ltd., New Delhi, 2002.
4. Syal I C, "Behaviour, Analysis and Design of Reinforced Concrete structural Elements" S. Chand & company, New Delhi, 2003.
5. MacGregor J G, "Reinforced Concrete- Mechanics and Design", Prentice Hall, N.J., New York,1997.

CEPC-306 Design of Steel Structures-I 3 1 0 4

Course Objectives

- To make students aware about different types of steel joints and their design.
- To share knowledge of design provisions given in Indian standard code.

- To make students aware about the concepts of basic elements like, tension and compression members, column bases, plate girder.
- To provide knowledge about the analysis and design the roof trusses.

Course Syllabus

Joints: Introduction to different joints,Stresses in bolts, strength and failure of bolted joints, Types of welds and welded joints, stresses in welds, design of welds, eccentrically loaded welded joints

Tension Members: Types of tension members, net and gross areas, permissible stresses. Design of members subjected to axial loads, combined bending moments and axial loads, lug angles. Tension Splice

Compression Members: Failure modes of columns, end conditions and effective length of columns, various empirical formulae. IS code formula, General codal provisions for design of compression members, Built up compression members, lacing and battening of compression members, splicing of compression members.

Column Bases and Foundations: Types of column bases, design of slab base, Gussetted base and grillage foundations.

Design of Flexural Members: Failure modes permissible stresses, design of laterally supported and unsupported beams, web crippling, web buckling, compound beams.

Design of plate Girders: Components of a plate girder, basic design assumptions, stiffeners in plate girders, design of various components of a welded and riveted plate girder.

Roof Trusses: Types of roof trusses loads on roof trusses, calculation of forces due to combination of different loads, Design of members and joints.

Course outcomes

- Understand the different types of steel joints and their design.
- Knowledge of design provisions given in Indian standard code.
- Able to design the basic elements like, tension and compression members, column bases, plate girder.
- Able to analyze and design the roof trusses.

Text and Reference Books:

1. Chandra R, “Design of Steel Structures” Standard Publishing House, 1999.
2. Raghupathi M, “Design of Steel Structures” Tata McGraw-Hill, New Delhi, 1998.
3. Arya A S and Ajmani J L, “Design of Steel Structures” Nem Chand Bros. Roorkee,2000.
4. Kazimi S M A and Jindal R S, “Design of Steel Structures” Prentice Hall of India, New Delhi,1999.
5. Dayaratnam P, “Design of Steel Structures” Wheeler Publishers, New Delhi, 1999.

CEPC-308 Elements of Earthquake Engineering 3 1 0 4

Course Objectives

- To make the students familiar with the dynamics problems for damped and undamped free vibration for single degree freedom system.
- To make the students understandable regarding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To do seismic design and detailing of structures with reference to is code.

Course Syllabus

Undamped free vibrations of single degree of freedom systems: Introduction, definitions, characteristics of a dynamic problem, degrees of freedom, Newton’s law of motion, De Alembert’s Principal, free body diagram, derivations of differential equation of motion, solution of differential equation of motion, equivalent stiffness of spring combinations, springs in series, springs in parallel.

Damped free vibrations of single degree of freedom systems: Introduction, types of damping, free vibrations with viscous damping, over-damped, critically- damped and under- damped systems, logarithmic decrement, structural damping.

Earthquake Resistant Design Philosophy: Introduction, criteria for earthquake resistant design, principles of reliable seismic behaviour, structural forms for earthquake resistance, earthquake forces versus other forces.

Lateral Load Analysis: Idealization of structures and selection of analysis, equivalent lateral force concepts, response spectrum analysis, seismic forces as per IS : 1893 – 1984 and IS : 1893 – 2002.

Behaviour and Design of Concrete Structures: Characteristics of concrete and reinforcing steel, influence of bond and anchorage and confinement of concrete, Seismic design and detailing of reinforced concrete and masonry buildings (IS 13920; IS 13827: IS 13828; IS 4326) and flexural strength and ductility of RC members.

Course outcomes

- Study the dynamics problems for damped and undamped free vibration for single degree freedom system.
- Understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian Standard code.
- Able to do seismic design and detailing of structures with reference to IS code.

Text and Reference Books:

1. Paz M, “Structural Dynamics – Theory and Computation” CBS Publishers and Distributors, New Delhi, 2003.
2. Chopra A K, “Structural Dynamics” John Wiley & Sons, New Delhi, 2002.
3. Dowrick D J, “Earthquake Resistant Design for Engineers and Architects” John Wiley & Sons, New York, 2000.
4. Paulay and Priestley, “Seismic Design of Reinforced Concrete and Masonry Buildings” John Wiley and sons, New York, 1992.
5. Rao S S,”Mechanical Vibrations” Pearson Education Publishers, 2004.

CEPC- 322 Concrete Structures-II Drawing 0 0 2 2

Course Objectives

- To make the students familiar with the use of relevant Indian Standard specifications applicable to design of steel structures.
- To prepare detail drawings of different components of RCC buildings.

Course Syllabus

Structural Drawings/Reinforcement detailing of

- R.C.C. Footings
- Beams curved in plan
- Domes
- Staircases
- Retaining Walls
- Water Tanks

Course outcomes

- Use of relevant Indian Standard specifications applicable to design of steel structures.
- Prepare detail drawings of industrial building, steel foot bridge and railway bridge.

CECI-302 Minor Project (Phase II) * 0 0 2 2

* Minor Project allotted in 5th Semester, will continue during the 6th semester and be evaluated after 6th Semester.

SEVENTH SEMESTER

CEPC-401 **Design of Hydraulic Structures** **3 0 0 3**

Course Objectives

- To inculcate the essentials of hydraulic structures in Civil Engineering field.
- To provide the students an illustration of the significance of the hydraulic structures in Civil Engineering Profession in satisfying societal needs.
- To demonstrate various methods to design these structures and show its economic

Course Syllabus

Dams: Gravity dams, arch dams and earthen dams, also introduction about rivers and canal projects in Punjab.

Earth Dams: Components of earth dams and their functions, Phreatic line determination by analytical and graphical methods.

Theory of Seepage: Seepage force and exit gradient, salient features of Bligh's Creep theory, Lane's weighted Creep theory and Khosla's theory Determination of uplift. Pressures and floor thickness.

Gravity Dams-Non Overflow Section: Forces acting, Stability factors, stresses on the faces of dam, Design of profile by the method of zoning, Elementary profile of a dam.

Gravity Dams Spillways: Creagers profiles neglecting velocity of approach, profile taking velocity of approach into account, upstream lip and approach ramp, Advantages of gated spillways, Discharge characteristics of spillways.

Arch Dam: Classification of arch dam-constant radius constant angle and variable radius types, cylinder theory, expression relating central angle and cross-sectional area of arch. Types of buttress dams, advantages of buttress dams.

Energy Dissipation Devices: Use of hydraulic jump in energy dissipation, Factors affecting design, types of energy dissipation and their hydraulic design.

Dam's Safety: instruments, stress-strain meter, piezometric reading of seepage, seepage analysis, sensors.

Canal Falls: Necessity and location, types of falls and their description, selection of type of falls, principles of design, design of Sarda type, straight glacis and inglis or baffle wall falls.

Distributory Regulators: Off take alignment, cross regulators-their functions and design, Distributory head regulators - their functions and design, canal escape.

Cross Drainage Works: Definitions, choice of type, hydraulic design considerations. Aqueducts their types and design, siphon aqueducts their types and design considerations, super passages, canal siphons and level crossings.

Design of Weirs: Weirs versus barrage, design consideration with respect to surface flow, hydraulic jump and seepage flow. Design of a barrage or weir.

Tunnels: Head-race tunnel, diversion tunnel.

Course outcome:

- Analysis and Design of different types of dams like, gravity dams, arch dams, buttress dams, earthen dams.
- Design of canal outlets.
- Design of cross drainage works and diversion head works.
- Study of theory of seepage
- To know about energy dissipation devices and their applications

Text and Reference Books:

1. Sharma S K, "Design of Irrigation Structures" S. Chand & Company (Pvt.) Ltd., New Delhi.
2. Murty C S, "Design of Minor Irrigation and Canal Structures" Wiley Eastern Ltd. New Delhi.
3. Garg S K, "Irrigation Engineering & Hydraulic Structures" Khanna Publishers, Delhi,1999.
4. Arora K R, "Irrigation Waterpower & Water Resources Engineering" Standard Publishers Distributors, Delhi, 2003.
5. Asawa G L, "Irrigation Engineering" Wiley Eastern Ltd., New Delhi 2001.

CEPC-403 Design of Steel Structures-II 3 0 0 3

Course Objectives

- To make the students familiar with design the round tubular structures.
- To make the students familiar with design of steel foot bridge and its various components.
- To make the students familiar with design of complete industrial building.
- To carry out analysis and design of single track railway bridge.

Course Syllabus

Design of Round Tubular Structures: Introduction, round tubular sections, permissible stresses, tube columns and compression members, tube tension members, tubular roof trusses, Design of tubular beams, Design of tubular purlins.

Design of steel foot bridge: Introduction, design of flooring, cross girders, analysis of N- type truss, design of various members of truss, design of joints, design of bearings.

Design of complete industrial building with design of:

a) Gantry Girder

b) Column bracket.

c) Mill bent with constant moment of inertia

d) Lateral and longitudinal bracing for column bent etc.

Design of a single track through type Railway Bridge with lattice girders having parallel chords (for B. G):

a) Design of stringer and stringer bracing

b) Design of cross girders

c) Design of connection between stringer and cross girder

d) Design of main girders – various members and their joints

e) Design of bottom lateral bracing and top lateral bracing

f) Design of portal bracing and sway bracing

Design of bearings – rocker and rollers

Course outcomes

- Able to design the round tubular structures.
- Design of steel foot bridge and its various components.
- Design of complete industrial building.
- To carry out analysis and design of single track railway bridge.

Text and Reference Books:

1. Arya A S and Ajmani J L, “Design of Steel Structures” Nem Chand & Bros, Roorkee,1996.
2. Chandra R, “Design of Steel Structures” Vol. I & II Standard Book House, Delhi,1991
3. Raz S A, “Structural Design in Steel” New Age International (P) Ltd., New Delhi, 2002
4. Raghupathi M, “Design of Steel Structures” Tata McGraw-Hill Publishing Company ltd., New Delhi, 1999.
5. Dayaratnam P, “Design of Steel Structures” Wheeler Publishers, New Delhi, 2000.

CEPC-421 **CAD Laboratory** **0 0 2 2**

Course Objectives

- To provide students with a broad introduction to Computer-Aided Design (CAD) and modeling with a focus on construction- and architecture-specific applications.
- To make students familiar with the use of industry-leading CAD software programs so that they can model construction projects, and then create and distribute basic, industry-standard architectural drawings.

Course Syllabus

Intro to CAD, Intro to AutoCAD, Precision Drawing & Drawing Aids, Geometric Shapes, Basic Printing, Editing Tools, Architectural Views & Drafting Views with AutoCAD (Surfaces, Solids), Annotating in AutoCAD with Text & Hatching Layers, and Templates. Advanced plotting (Layouts, Viewports), Office Standards, Dimensioning, Internet and collaboration, Blocks, Drafting symbols, Attributes. Drawing of various components of RCC and Steel constructions

Course outcomes

- Understanding of the power and precision of computer-aided modeling and drafting;
- Ability to construct accurate 2D geometry as well as complex 3D shapes and surface objects;
- Ability to create 2D representations of 3D objects as plan view, elevations and sections;
- Ability to assemble these drawings in industry-standard plan form and produce plotted hardcopies ready for distribution;
- Awareness of architectural drafting with a focus on industry standards

CECI-300 **Industrial Practical Training*** **0 0 0 0**

Industrial Practical Training will be held during summer vacation after sixth semester and will be evaluated in 7^{th} semester.

CECI-400 **Major Project (Phase I)** **0 0 4 4**

Independent study by the student in any area of interest related to civil engineering.

EIGHTH SEMESTER

CEPC-402 **Estimating and Costing** **3 0 0 3**

Course Objectives

- To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering.
- To provide the students knowledge regarding estimation of quantities involved in Civil engg. works

Course Syllabus

Estimates: Types, complete set of estimate, working drawings, site plan, layout plan, index plan, plinth area, administrative approval and Technical Sanction.

(i) Estimate of buildings

(ii) Estimate of R. C.C. works

(iii) Estimate of sloped roof and steel structures

(iv) Estimate of water supply and sanitary works

(v) Estimates of roads (a) Earthwork (b) Bridges and culverts c) Pavement

(vi) Estimate of Irrigation works.

Analysis of Rates: For earthwork, concrete works, D. P. C., Brickwork, stone masonry, plastering, pointing, road work, carriage of materials.

Specifications: General specification for different classes of building, detailed specifications for various Civil Engineering Works.

Contracts: Types of contracts, tender, tender notice, tender form, submission and opening of tender, earnest money, security money, measurement book, muster roll, piecework agreement and work order

Accounts: Division of accounts, cash, receipts of money, cashbook, temporary advance, imprest and accounting procedure.

Arbitration: Arbitration, arbitrator and arbitration act, powers of arbitrator, arbitration awards.

Course Outcomes

- Able to prepare rough and detailed estimate of buildings for different items.
- Knowledge of specifications of different items of building.
- Able to perform rate analysis of different work items.

- Knowledge of contracts, accounts and arbitration.

Text and Reference Books:

1) Chakraborti, M., 2002. Estimating and costing, Calcutta.
2) Dutta, B. N., 1999. Estimating and costing in civil engineering. UBS Publishers' Distributors Ltd., New Delhi.
3) Birdie, G. S., 1994. Estimating and costing, Dhanpat Rai & Sons, Delhi.
4) Kohli, D. and Kohli, R.C., 2004. Estimating and costing. S.Chand & Company, New Delhi.
5) Spence, G., 1950. Building and public works administration: estimating and costing. Newnes Publishers, London, UK.

CECI-402 Industrial Lecture 1 0 0 1

Minimum 04 Industrial lectures are to be organized by the department in final year of study. The grades are to be awarded based upon quizzes on the same day of lecture.

CECI-400 Major Project (Phase-II)* 0 0 8 8

Major Project allotted in 7^{th} Semester, will be evaluated after 8^{th} Semester.

Departmental Electives:
Elective-I (Sixth Semester)

CEPE-332 Plastic Analysis of Structures 3 0 0 3

Course Objectives

- To apply the theorems and methods and principles of limit analysis of structures under various actions.
- To understand the concept and use of ductility factors.
- To use regulations for analysis and design of plastic structures, in addition to automatic calculation programs in structural analysis, for understanding the analysis results and the design principles.

Course Syllabus

Introduction: Ductility of metals: Concept of plastic design, Overloaded factors, Ultimate load as design condition.

Analysis of Indeterminate Structures: Hinge formation in indeterminate structures, Redistribution of moments, Assumption made for structure subjected to bending only.

Minimum Weight Design: Concept, assumption, Design of frame with prismatic members, Elements of linear programming and its application to minimum weight design problems.

Deflection: Assumption, Calculation of deflection at ultimate loads, Permissible rotations.

Secondary Design Considerations: Influence of direct load, shear local bucking, lateral bucking, repeated loading and brittle fracture on moment capacity. Design of eccentrically loaded columns. Problem of incremental Collapse, Shake down analysis. Special considerations for design of structures using light gauge metals.

Course outcomes

- Introduction to plastic design.
- Able to do analysis of indeterminate structures.
- An understanding of Special considerations for design of structures using light gauge metals.
- Calculation of deflections at ultimate loads.

Text and Reference Books:

1. Neal B G, “Plastic Methods of Structural Analysis” Chapman Hall, London, 1977.

2. Manika Selvam V K, “Limit Analysis of Structures” Dhanpat Rai Publications, New Delhi, 1997.

3. Arya A S and Ajmani J L, “Design of Steel Structures” Nem Chand & Bros, Roorkee,1992.

4. Chandra R, “Design of Steel Structures” Vol. I & II Standard Book House, Delhi, 1999.

5. M.P. Nielsen, “Limit Analysis and Concrete Plasticity” CRS Press, London, 1998.

CEPE-334 Structural Analysis-III 3 0 0 3

Course Objectives

- Introduce flexibility method for analysis of statically indeterminate structures.
- Introduce stiffness method for analysis of statically indeterminate structures.
- Introduce finite difference method for analysis of slabs
- Introduce introduction to finite element method for analysis of statically indeterminate structures

Course Syllabus

Review of Determinants and Matrices: Introduction, summation convention, determinants and their properties, Cramer’s rule, matrices and their properties, solution of non-homogeneous equations by matrix methods, differentiation and integration of a matrix.

Flexibility method of Analysis: Introduction, method of consistent deformation, application to pin jointed frames, effect of temperature and pre-strain, displacements and forces in members of indeterminate structures, flexibility matrix of a plane member.

Stiffness Method of Analysis: Introduction, relation between slope deflection method and stiffness method, choice between flexibility and stiffness method, stiffness method for members with relative displacement of supports, analysis of indeterminate structures, analysis of pin-Jointed frames.

Computer Applications: Matrix structural analysis using spreadsheets, MS Excel Matrix Commands, MS Excel procedure for stiffness method of analysis, analysis of single span beams, continuous beams, plane trusses and plane frames.

Course outcomes

- Review of matrices and determinants.
- To perform analysis of beams and pin jointed frames by flexibility and stiffness methods.

- To develop ms spread sheets for matrix analysis.

Text and Reference Books:

1. Gere W and Weaver J M, “Matrix Analysis of Structures” CBS Publishers, New Delhi, 1986.
2. Kanchi M B, “Matrix Methods of Structural Analysis” Wiley Eastern Limited, New Delhi, 2002.
3. Ganju T N, “Matrix Structural Analysis using Spreadsheets” TMH Publishing Co. Ltd. New Delhi,2002.
4. Vazirani V N and Ratwani M M, “Advanced Theory of Structures and Matrix Methods” Khanna Publishers, New Delhi, 1995.
5. Pandit G S and Gupta S P, “Structural Analysis A Matrix Approach” Tata McGraw Hill, New Delhi, 1994.

CEPE-336 Hydrology and Dams 3 0 0 3

Course Objectives

- To provide information of hydrological cycles
- To show the all the processes, simulation and factors of hydrological cycles
- To estimate the quantity of water in subsurface and surface zones.
- To evaluate the peak flow in natural streams for designing of hydraulic structures

Course Syllabus

Introduction, Precipitation, Importance of hydrological data in water resources planning. The hydrologic cycle. mechanics of precipitation, types and causes, measurement by rain gauges, Gauge net-works, hyetograph, averaging depth of precipitation over the basin, mass-rainfall curves, intensity duration frequency curves, depth area-duration curves.

Interception, Evapo-transpiration and infiltration: Factors affecting interception. Evaporation from free water surfaces and from land surfaces, transpiration, Evapo-transpiration.

Infiltration-Factors affecting infiltration, rate, infiltration capacity and its determination.

Runoff: Factors affecting runoff, run-off hydrograph, unit hydrograph theory, S-curve hydrograph, Synder’s synthetic unit hydrograph.

Peak Flows: Estimation of Peak flow-rational formula, use of unit hydrograph, frequency analysis, Gumbel's method, design flood and its hydrograph, Principles of flood routing through a reservoir by ISD method (description only).

Dam's hydrology: Outflow hydrograph of dam, stage hydrograph, flow routing, topography and flood inundation using Arc GIS.

Ground water hydrology - Introduction, types of aquifers, wells, well yield

Course outcome:

- Understand the hydrological cycle and its importance in water resource planning.
- Understand the concept of evapo transpiration, interception and infiltration.
- Estimation of surface runoff and peak flows using unit hydrograph theory.
- Analysis of different types of dams like, gravity dams, buttress dam, earthen dam.

Text and Reference Books:

Subramanya K, "Engineering Hydrology" Tata McGraw-Hill, New Delhi, 2001.

1. Wilson E M, "Engineering Hydrology" ELBS, English Language Book Society/Macmillan Education Ltd. London, 1999.
2. Raghunath H M, "Hydrology" Wiley Eastern, New Delhi, 2000.
3. Pence V M, "Hydrology – Principles and Practices" Prentice Hall, New Jersy. , 1998.
4. Karanth K R, "Hydrology" Tata McGraw Hill, New Delhi 2001.
5. ArcGIS software (prefer latest version).

CEPE-338 Advanced Construction Practices 3 0 0 3

Course Objectives

- To share overview of latest concrete construction methods.
- To make the students understandable of various methods of handling and placing of concrete.
- To make the students familiar with the construction techniques in marine environment.

- To make students aware about the quality and safety measures in construction works.

Course Syllabus

Concrete Construction Methods,Formwork Design and Scaffolding; Slip Forms and other moving forms; Pumping of Concrete; Grouting and Mass Concreting Operations(roller compacted concrete); Ready-Mix Concrete; Various Methods of Handling and Placing Concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Prestressing. Steel and Composite Construction Methods, Fabrication and erection of structures including heavy structures, Prefab construction, Industrialized construction and Modular coordination. Special Construction Methods, Construction in Marine Environments, High Rise Construction, Bridge Construction including Segmental Construction, Incremental Construction and Push Launching Techniques; Geosynthetics; Safety, Quality Measures and Reliability

Course outcomes

- To get overview of latest concrete construction methods.
- An understanding of various methods of handling and placing of concrete.
- Understand the construction techniques in marine environment.
- To make aware the quality and safety measures in construction works.

Text and Reference Books:

1. Neville A M and Brooks J J, "Concrete Technology" Pearson Education Asia, Singapore, 1994.
2. Neville A M, "Properties of Concrete" Pearson Education, New Delhi, 2004.
3. Peurifoy R L, "Construction Planning, Equipment and Methods" McGraw Hill Ltd., New York, 2002.

CEPE-340 Elements of Remote Sensing and GIS 3 0 0 3

Course Objectives

- To study the fundamental concepts of geographic information systems
- To study the fundamentals of remotely sensed data and its integration with geographic information systems

Course Syllabus

Introduction to Geographic Information System: Definitions and related terminology, evolution of GIS, components of GIS, approaches to the study of GIS.

Maps and GIS: Introduction, Map scale and classes of maps, the mapping process, plane coordinate systems and transformations, geographic coordinate system of earth, map projection, georeferencing and topographic mapping.

Digital Representation of Geographic Date: Introduction, database and database management systems, raster geographic date representation, vector data representation, data representation and data analysis in GIS.

Raster Basic GIS Data Processing: Introduction, acquiring and handling raster geographic data, raster based GIS data analysis, cartographic modeling.

Vector Based GIS Data Processing: Introduction, Characteristics of vector based GIS data processing, topological and non-topological functions.

Remote Sensing: Introduction, Spectral Reflectance Signature, Digital Image Processing, Visual Interpretation of Satellite data, Aerial Photo and Its Interpretation, Advanced Remote Sensing Technologies, Advantages and Benefits of RS, Overview on Remote Sensing Technology, Fundamentals of Remote Sensing, Physics of Electro Magnetic Energy, Remote Sensing Platforms, Sensors and Data Products, Remote Sensing Applications, Indian Remote Sensing Systems.

Applications of Technology: Water shed Studies, Flood Studies, Ground water Studies, Health Issues, Utility Studies, Security and Defense Studies, Urban and infrastructure Studies

Courseoutcomes

- Introduction to basis of GIS.
- Understand the mapping process and geographical coordinate system of earth.
- Able to do vector based and raster based data processing.
- Knowledge of remote sensing and its components.
- To apply integration of remote sensing and GIS.

Text and Reference Books:

1. Lo C P and Young K W, “Concepts and Techniques of Geographic Information Systems” PHI Pvt. Ltd, New Delhi, 2002.
2. Campbell J B, “Introduction to Remote sensing” CBS Publishers & Distributors, New Delhi,2003.
3. Burrough P A, “Principles of Geographic Information Systems for Land Resources Assessment” Oxford University Press, 2003.
4. Duggal S K, “Surveying Volume 2” Tata McGraw Hill, New Delhi, 2004.
5. Donnay J P, “Remote Sensing and Urban Analysis” CBS Publishers & Distributors, New Delhi,2003.

CEPE-342 Highway Pavement Design and Construction 3 0 0 3

Course Objectives

1. To study the different types of highway pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations using in the flexible and rigid pavements and subsequent, the design of these pavements.
4. To introduce the constructions of different types of highway pavements and use of ground improvement techniques w.r.t. application in highway constructions.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories , ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.

Flexible Pavement Design: Various approaches for designing the pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods; design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods; design of pavements using these methods, design of joints

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement construction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc., highway drainage with special considerations to be given in hilly areas.

Ground Improvement Technique:

Different method of soil stabilization, use of geotextiles, geogrids and fibres in highway construction, use of sand drains and band drains.

Evaluation and Strengthening:

Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, different overlays overview of the revision of specifications pertaining to the various methods of designing the overlays, design of different types of overlay , skid resistance and measurement

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of such pavements.

Course Outcomes:

On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads and the use of ground improvement techniques in the context of road constructions.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;
5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
4. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
5. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
6. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A.,2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
7. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
8. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.
9. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.

10. Chakraborty, P. and Das, A., 2013. Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

10 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

11. Yoder E.J. and Witzack M.W. , 1991. Principles of Pavement Design; John Wiley and Sons, New York.

12. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi

13. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)

14. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)

15. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.

IRC: 58-2011. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.

IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi

IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

Departmental Electives:
Elective-II, III (Seventh Semester)

CEPE-431 Advanced Foundation Engineering 3 0 0 3

Course Objectives

1. Knowledge of different tests for soil exploration.
2. To get familiar general design principles of foundation design with reference to Indian code.
3. Able to analyze and design of bridge sub-structure components.
4. Understating the behavior of foundations in expensive soils.

Course Syllabus

Shallow Foundations: Introduction, bearing capacity of footings, skemptons bearing capacity factor, footings on layered soils, footings with eccentricity, allowable bearing pressure, raft foundations floating raft, uplift capacity of footing.

Pile Foundations: Introduction, bearing capacity of piles, vertical piles subjected to lateral loads, proportioning and design of pile foundations, lateral load capacity of single pile, batter piles under lateral load, uplift capacity of piles ultimate lateral load resistance of a pile group.

Drilled Piers: Introduction, current construction methods, use of Drilled Piers, analysis and design of drilled piers, settlements of drilled piers, structural design of drilled piers, laterally loaded drilled pier analysis.

Bridge Sub Structures: Definitions, elements of substructures, maximum depth of scour, depth of foundation allowable bearing pressure, loads to be considered, lateral stability, design of pier cap & pier, sinking stresses in wells, design of well cap, well staining, well curb, cutting edge, bottom plug.

Sheet Piles and Coffer Dams: Types of sheet piles structures, design of cantilever sheet pile wall, design of anchored bulkheads, anchorage methods design of braced sheeting in cuts, Design of cellular coffer dams. Calculation of allowable bearing pressure. Conditions for stability of a well. Terzaghi's analysis for Lateral stability of a well, embedded in sand. Forces acting on a well foundation. Computation of scour depth, Tilts & Shifts.

Foundation in Expansive Soils: Introduction, Material structure, identification of expansive soils, Indian expansive soils, swell potential and sewelling pressure, traditional Indian practice, methods of foundations in expansive soils, replacement of soils and CNS concept. Underreamed pile foundations, remedial measures for cracked buildings.

Course Outcomes:

- Students will be able to design foundation on slopes, foundation with eccentricty
- Students will be able to design the piles subjected to lateral and uplift loads
- Students will be able to analyze and design drilled piers and well foundations

- Students will be able to analyze and design sheet piles and coffer dams
- Students will be able to plan and design foundations on expansive soils

Text and Reference Books:

1. Ranjan, G. and Rao A.S.R., 2000. Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
2. Murthy V N S., 2001. Principles of Soil Mechanics and Foundation Engineering. UBSPD.
3. Das, B.M. 2004. Principles of Foundation Engineering. Cengage Pulishers
4. Couduto, D.P., 2002. Geotechnical Engineering – Principles and Practices", Prentice Hall of India.
5. Peck R. B., Hanson W. B. and Thornburn T. H., 1974. Foundation Engineering. John Wiley and Sons Inc, New York.
6. Bowles J. E., 1988. Foundation Analysis and Design. McGraw Hill, New York.

CEPE-435 Industrial Structures 3 0 0 3

Course Objectives

- To make the students familiar with identification of different types of industrial structures and their components.
- To make students aware about design of various structures like, bunkers, silos, chimneys, virendreel girders.
- To make the students knowledgeable for general requirements of machine foundation, their analysis and design.

Course Syllabus

Bunkers and Silos: Introduction, Analysis of Bunkers and Silos, Janssen's and W. Airy's formulas for design of silos, Bunker with a hopper bottom.

Shell Roofs and Folded Plates: Introduction, Terminology, classification and general specifications. Analysis of shells by different methods, general design considerations, design of folded plates by different theories.

Machine Foundations: Introduction, General requirements, foundations for reciprocating, impact type and rotary type machines. Type of connections.

Braced Industrial Buildings: Introduction, design of goodowns, small Industrial shed with a gantry girder.

Virendeel Girders: General features, analysis of virendeel girders. Design of members.

R.C. C. Chimneys: Introduction, Design for Stresses due to self-weighs, wind, load, stress due to temperature gradient, combined effects of self-load, wind load & temperature.

Courseoutcomes

- Identification different types of industrial structures and their components.
- Able to analyze and design of various structures like, bunkers, silos, chimneys, virendreel girders.
- Knowledge of general requirements of machine foundation, their analysis and design.

Text and Reference Books:

1. Raju N K,"Advanced R. C. C. Design" Tata McGraw Hill, New Delhi, 2000.
2. Chandra R, "Design of Steel Structures" Vol. II Standard Publication House, New Delhi, 1991.
3. Syal I C, "Behaviour Analysis and Design of R. C. C. Structure" S. Chand & company, New Delhi, 2003.
4. Ramaswamy G S, "Design and Construction of Concrete Shell Roofs" CBS Publication House, New Delhi.
5. Arya A S and Ajmani J L, "Design of Steel Structures" Nem Chand & Bros, Roorkee.1992.

CEPE-437 Pre-stressed Concrete Design 3 0 0 3

Course Objectives

- To recognize the effects of transfer and development length on flexural and shear strengths.
- To construct moment-curvature and load-deflection curves for a prestressed concrete beam.
- To analyze and design prestressed concrete members for shear.
- To become familiar with professional and contemporary issues in the design and fabrication of prestressed concrete members.

Course Syllabus

Introduction: Basis concepts, Materials used, advantages of prestressed Concrete, Applications of prestressed concrete.

Materials for prestressed Concrete: High strength concrete, strength requirements permissible stresses in concrete, creip & shrinkage, deformation characteristics, high strength steel, strength requirements, permissible stress in steel.

Prestressing Systems: Introduction, prestensioning systems, post-tensioning systems, chemical prestressing.

Losses of Prestress: Nature of losses, different types of losses and their assessment.

Analysis of Prestress & Bending Stress: Basic assumptions, Resistant stresses at a section, pressure line, and concept of land balancing, stresses in grading moment.

Flexural Shear Strength of Prestressed Concrete Sections: Types of flexural failure, strain compatibility method, code procedures, shear and principal stresses, ultimate shear resistance of pressed concrete members, prestressed concrete members in torsion.

Transfers of Prestress in Pre-tensioned and Post-tensioned members: Transmission Length, bond structures, Transverse tensile stress End-zone reinforcement, stress distribution in end block.

Design Prestressed Concrete Sections: Design of section for flexure, Axial tension compression & bending, shear, bond and torsion.

Design of concrete Pipes & Tanks: Circular prestressing type of prestressed concrete pipes, design of prestressed concrete pipes, Analysis and design of prestressed concrete tanks.

Course outcomes

- To apply basic concepts, applications and advantages of prestressed concrete.
- Knowledge of materials of prestressed concrete and their properties.
- To carry out analysis and design of prstressed concrete sections.
- Design of prestressed concrete pipes and tanks.

Text and Reference Books:

1. Raju N K, “Prestressed Concrete” Tata McGraw Hill, New Delhi, 2001.

2. Rajagopalan N, “Prestressed Concrete” Narosa, New Delhi, 2001.

3. Dayaratnam P, “Prestressed Concrete” Oxford & IBH, New Delhi, 1999.

4. Lin T Y, “Prestressed Concrete” McGraw Hill, New York, 1985.

5. Edward G Nawy, “Prestressed Concrete-A Fundamental Approach” Prentice Hall Publishers, NY, 2000.

CEPE-439 **Finite Element Methods in Engineering** **3 0 0 3**

Course Objectives

- To provide students with an introduction to Finite Element Analysis and to help the students use this method and commercial software package to solve problems in structural elements and mechanics of materials.
- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- This course provides an introduction to finite elements method with a focus on one and two dimensional problems in structures, static and dynamics.

Course Syllabus

Introduction, background and applications, general description of the method, summary of the analysis procedure, matrix theory, differential equations.

Review of Solid mechanics: Equations of equilibrium, stresses and strains, strain displacement relations, linear constitutive relations, two – dimensional elasticity, non-linear material behaviour, material characterization.

One – dimensional finite elements: The concept of an element, various element shapes, displacement models, finite element modelling, coordinates and shape functions, stiffness matrix, the finite element equations and treatment of boundary conditions.

Two-dimensional finite elements: Introduction, two-dimensional boundary value problems, various element shapes, constant strain triangular elements, quadrilateral elements, natural coordinates, connectivity and nodal coordinates, problem modelling and boundary conditions.

Two-dimensional Isoparametric Elements: Introduction, the four-nodded quadrilateral element, numerical integration, interpolation formulas and shape function formulas, computations of element stiffness matrix.

Beams and Frames: Introduction, finite element formulation, load vector, boundary conditions, displacement method for beam analysis, beam finite elements, shear force and bending moment, plane frames.

Course outcomes

- To get familiar about background and applications of FEM.
- Introduction to one –dimensional and two- dimensional finite elements.
- Introduction, the four-nodded quadrilateral element, its computation of stiffness matrix.
- To performs FEM analysis on beams and frames.

Text and Reference Books:

1. Desai C S and Abel J F, “Introduction to the finite element method” CBS Publishers and Distributions, Delhi, 2004.
2. Buchanan G R, “Schaum’s Outline Series, Theory and Problems of Finite Element Analysis” McGraw Hill International Edition/Tata McGraw Hill, New Delhi, 2004.
3. Chandrupta T R and Belegundu A D, “Introduction to Finite Elements in Engineering” PHI, New Delhi,1997.
4. Krishnamoorthy C S, “Finite Element Analysis – Theory and Programming” TMH Publishing Co. Ltd. New Delhi, 2002.
5. Bathe K J, “Finite Element Procedures” Prentice Hall of India, New Delhi, 1997.

CEPE-441 **Architecture and Town Planning** **3 0 0 3**

Course Objectives

- To make the students knowledgeable about design elements of architecture.
- To make the students familiar with the industrial revolution.
- To make the students understandable the concepts of town planning.
- To make use of general principles and techniques of town planning.

Course Syllabus

Elements of Design: Line direction. Shape, size, texture, value and colour, balance, scale and proportion.

Principles of Design: Repetition, gradation, harmony, contrast and unity, creation of 2 D and 3 D compositions.

The Industrial Revolution: The age of revivals, the emergence of engineer, new materials and techniques and the evolution of balloon frame and steel frame.

Origin of Modern Architecture: definition and concept of modern architecture, various pioneers of modern architecture.

Town Planning: Definition and meaning, age of planning, scope and motives of planning, brief history of town planning – its origin and growth, historically development of town planning in ancient valley civilizations. Indus Nile Tigris and Euphrates, Greek Roman, Medieval and Renaissance town planning

New Concepts: Garden city movement, Linear city and concentric city concepts, Neighbourhood and Radburm, La-cite industrille, Radiant city to present day planning.

Planning Principles: Types of town and their functions, types of town planning – Grid Iron, Radial, Spider webs, Irregular and Mixed, their advantages and disadvantages.

Planning Practice and Techniques: Zoning – its definition, procedure and districts, height and bulk zoning, F. A. R., Master Plan – Meaning, preparation and realization, the scope of city planning – city rehabilitation and slum clearance.

Courseoutcomes

- Knowledge of design elements of architecture.
- To review the industrial revolution.
- Understanding the concepts of town planning.
- To apply the general principles and techniques of town planning

Text and Reference Books:

1. Cherry, Gordon,"Urban Planning Problems" Board Hill, London,1974.
2. Sundaram,K V ,"Urban and Regional Planning in India" Vikas Publishing house(P) Ltd.,New Delhi,2000.
3. Gallion A B,Eisner S, "The Urban Pattern" Van Nostrand reinhold,New York,1993.
4. Jon Lang,"A concise history of Modern Architecture in India" Permanent Black Publishers,New York,1998.
5. Taurus Parke,"A City with view Florence" I.B.Taurus Publishers, New York, 1994.

CEPE-449 **Smart Cities** **3 0 0 3**

Course Objectives

- To make the students familiar with the elements of planning for pre-exist and new-planned cities.
- To make students conversant with different systems like; road network, water distribution systems, sewer systems, municipal solid waste management and electrification systems etc.

Course Syllabus

Introduction to smart cities: Definition, Concept, Need and importance, Benefits of smart cities, Features & components of a smart city, Strategies to be adopted, Characteristics and factors of smart cities, Smart structures, Classification of smart structures, Challenges faced in developing smart cities, Scope of smart cities, Some examples of smart cities.

Introduction to Smart Materials: Natural materials, Sustainable materials, Types of smart materials- Active & Passive, Applications of different types of smart materials, Future Applications. Smart Construction, Planning & Design, Theory and principles, Orientation of buildings, Sustainable buildings- Concept of green buildings, Features of green building rating systems in India: LEED, GRIHA. Sustainable site, Green home rating system, Green neighborhood concept, Concept of Net zero energy building, Net zero community.

Power and energy requirements: Energy, material and indoor environmental issues for smart buildings, Alternate sources of energy, Renewable sources-biomass, geothermal, wind, solar, water, green fuels, Sustainable energy uses, Energy efficient techniques, Smart electricity, Smart Grid, Utility metering, substation automation.

Smart City Framework: : Smart Transport, Concept of smart transportation, Challenges Faced, Intelligent Transport systems- Background, Technologies, IT applications, periodic traffic forecasts, journey/route planning of public and private transport mobile applications (based on real time data), etc., Smart Traffic Signals, Smart Transport Cards, Smart Parking, Electric vehicles, Hybrid vehicles, charging stations, Urban transport systems, Vehicle tracking systems, Integrated traffic management, Examples.

Smart Water and Waste Management: Integrated water management, Solid waste management, Smart utility services, Water harvesting, Water pollution monitoring systems, Energy Optimization System for wastewater treatment, Smart water networks, Recycling systems and technologies, Waste to energy equipment, Sensor Based Waste Storage and Collection, Automated waste collection systems.

Course outcomes

- Various elements of planning for pre-exist and new-planned cities.
- Introduction to different systems like; road network, water distribution systems, sewer systems, municipal solid waste management and electrification systems etc.

Text and Reference Books:

1. Eleonra R S, Raffaella R S, Valentina V, “Smart Rules for Smart Cities” Springer
2. Mohammad O and Petros N, “ Smart Cities and Homes Key Enabling Technologies” Morgan Kaufmann
3. Carol L S, “ Building Smart Cities: Analytics and Design Thinking”

CEPE-453 Environmental Geo-technology 3 0 0 3

Course Objectives

- To make the students familiar with the elements of planning for pre-exist and new-planned cities.
- To make students conversant with different systems like; road network, water distribution systems, sewer systems, municipal solid waste management and electrification systems etc.

Course Syllabus

Introduction to smart cities: Definition, Concept, Need and importance, Benefits of smart cities, Features & components of a smart city, Strategies to be adopted, Characteristics and factors of smart cities, Smart structures, Classification of smart structures, Challenges faced in developing smart cities, Scope of smart cities, Some examples of smart cities.

Introduction to Smart Materials: Natural materials, Sustainable materials, Types of smart materials- Active & Passive, Applications of different types of smart materials, Future Applications. Smart Construction, Planning & Design, Theory and principles, Orientation of buildings, Sustainable buildings- Concept of green buildings, Features of green building rating systems in India: LEED, GRIHA. Sustainable site, Green home rating system, Green neighborhood concept, Concept of Net zero energy building, Net zero community.

Power and energy requirements: Energy, material and indoor environmental issues for smart buildings, Alternate sources of energy, Renewable sources-biomass, geothermal, wind, solar, water, green fuels, Sustainable energy uses, Energy efficient techniques, Smart electricity, Smart Grid, Utility metering, substation automation.

Smart City Framework: : Smart Transport, Concept of smart transportation, Challenges Faced, Intelligent Transport systems- Background, Technologies, IT applications, periodic traffic forecasts, journey/route planning of public and private transport mobile applications (based on real time data), etc., Smart Traffic Signals, Smart Transport Cards, Smart Parking, Electric vehicles, Hybrid vehicles, charging stations, Urban transport systems, Vehicle tracking systems, Integrated traffic management, Examples.

Smart Water and Waste Management: Integrated water management, Solid waste management, Smart utility services, Water harvesting, Water pollution monitoring systems, Energy Optimization System for wastewater treatment, Smart water networks, Recycling systems and technologies, Waste to energy equipment, Sensor Based Waste Storage and Collection, Automated waste collection systems.

Course outcomes

- Various elements of planning for pre-exist and new-planned cities.
- Introduction to different systems like; road network, water distribution systems, sewer systems, municipal solid waste management and electrification systems etc.

Text and Reference Books:

4. Eleonra R S, Raffaella R S, Valentina V, “Smart Rules for Smart Cities” Springer

5. Mohammad O and Petros N, " Smart Cities and Homes Key Enabling Technologies" Morgan Kaufmann
6. Carol L S, " Building Smart Cities: Analytics and Design Thinking"

CEPE-455 Traffic Engineering and Management 3 0 0 3

Course Objectives:

1. To understand all the traffic characteristics and further, different traffic surveys conducted for the analysis of the road transportation network.
2. To study different statistical methods w.r.t. their application in traffic engineering.
3. To study the various terms in regard with the capacity of a roadway, factors affecting capacities, different types of capacities.
4. To understand the significance of traffic control devices and different types of traffic control devices, their applications and to understand the intelligent transportation system.
5. To study the intersections, their types and application and design; and further, to study the causes of the road accidents and preventive measures along with traffic management system.
6. To study the facilities meant for parking and pedestrians; and highway lighting.

Course Syllabus

Traffic Characteristics: Road users' characteristics, vehicular characteristics, power performance of vehicles.

Traffic Studies: Various traffic studies (Speed including delay, volume, occupancy, origin-destination, parking, accident), objectives/ uses, methods of conducting these studies with pros and cons thereof, methods of analysis of data and interpretation of results, introduction to the photographic techniques in traffic surveys.

Statistical Methods and their Applications in Traffic Engineering: Distribution, sampling theoryand significance of testing, regression and correlation, traffic forecasting.

Highway Capacity: Passanger Car Unit, level of service, types of capacities, factors affecting capacity, capacity and level of service analysis

Traffic Control: Traffic control devices, Basic requirements, Different types of Traffic signs, Traffic Signals- Types and design, different types of pavement/ road markings, miscellaneous traffic control aids, introduction to intelligent transportation systems.

Road Intersections: Classification of intersections, factors to be considered in the design of intersection, requirements of different types of intersections, various forms of intersections, rotary intersections, design of rotary.

Accident and Road Safety: Accident causes, recording systems, analysis and preventive measures.

Traffic Management: Various measures and their scope, relative merits and demerits

Parking and Pedestrian Facilities: Classification and types of parking, Pedestrian facilities- Side Walks , Cross Walks

Highway Lighting: Need for street lighting, important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing, lantern arrangements, types of lamps, design of highway lighting system.

Course Outcomes

Upon the successful completion of the course, the learners:

1. Are expected to understand the complete knowledge of the traffic characteristics, traffic surveys and management skills related to various problems on roads/ streets.
2. Shall be able to analyze the large data bases generated out of extensive traffic surveys required to be carried out for planning the transportation network by resorting to the various statistical methods and its application in the planning.
3. Shall be able to plan and design the intersection, traffic signals and implement other traffic control devices such as traffic signs and pavement marking on the road transportation network for effective traffic engineering.
4. Are expected to get knowledge related to all the modern techniques and various approaches/ methods needed for effective traffic management.

Books Recommended:

1. Kadiyali, L.R., 2011. Traffic Engineering and Transportation Planning. Khanna Publishers, Delhi
2. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering. CBS Publishers and Distributors.
3. Papacostas, C.S. and Prevedouros, 2016. Transportation Engineering and Planning:, PHI Learning Pvt. Ltd. , New Delhi.
4. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering. S. Chand Publishers, New Delhi.
5. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2014. Highway Engineering: Nem Chand Bros. , Roorkee (10th Revised Edition)
6. Pignatro, G.J. , 1973. Principles of Traffic Engineering ; Mc-Graw Hill
7. Principles of Transportation Engineering: Chakraborti, P. and Das, Animesh; Prentice Hall (India)

Reference Books

1. Chakraborty, Partha and Das, Animesh, 2013. Principles of Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi
2. Papacostas, C.S. and Prevedouros, P.D., 2012.Transportation Engineering and Planning. Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Khisty, C.J. and Lall, Kent, B. 2018. Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi.

CEPE-457 Hydraulics and Hydraulic Machines 3 0 0 3

Course Objectives

- To introduce the importance of study of open channel flow, to give brief description on different types of flows and channels and hydraulic design principles of channels.

- To learn the fundamentals of Uniform and Non-Uniform flow in open channels.
- To understand about the concepts of specific energy, critical flow and their applications.
- To give an idea about the gradually varied flow and rapidly varied flow and their equations and computations.
- To introduce the concepts of momentum principles.
- To impart the knowledge on pumps and turbines.

Course Syllabus

Open Channel Flow - Uniform Flow

Introduction, Classification of flows, Types of channels; Chezy, Manning's, Bazin, Kutter's Equations; Hydraulically efficient channel sections - Rectangular, Trapezoidal and Circular channels; Velocity distribution; Energy and momentum correction factors; Pressure distribution.

Open Channel Flow - Non - Uniform Flow

Concept of specific energy; Specific energy curves; Critical flow; Critical flow in a rectangular channel; Critical slope; Different slope conditions; Channel transitions- Reduction in width of channels, hump; Momentum principle applied to open channel flow; Specific force.

Open Channel Flow - Gradually Varied Flow

Dynamic equation; surface profiles; Computation of surface profiles by single step method; Back water curves and Draw down curves; Examples of various types of water surface profiles.

Open Channel Flow - Rapidly Varied Flow

Hydraulic jump; Elements and characteristics of hydraulic jump; Types of hydraulic jump; Location and applications of hydraulic jump; Energy loss in a hydraulic jump.

Momentum Principles

Action of jets on stationary and moving flat plates and curved vanes; Angular momentum principle; Torque in roto dynamic machines.

Hydraulic Turbines

Classification; Impulse; Reaction; Radial, Axial, mixed and tangential flow turbines; Pelton, Francis turbines; Runner profiles; Velocity triangles; Head and efficiency; Draft tube theory; Similarity laws; Concept of specific speed and unit quantities; Selection of Turbines; Operational characteristics.

Centrifugal Pumps

Manometric head; Losses and efficiencies; Work done; Working Principle; Priming; Velocity triangles; Performance and characteristic curves; Cavitation effects; Similarity considerations.

Dimensional Analysis and Similitude

Dimensional homogenity; Rayleigh's method; Buckingham π -method ; Geometric, Kinematic and Dynamic similarities; Reynold's, Froude, Euler, Mach and Weber numbers; Model laws; Scale effect; Distorted models.

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Course outcomes

- To know the different types of flows and channels.
- To understand the performance of turbines and pumps.
- To know the applications of momentum principles.
- To make the student is expected to prepare models for prototypes of hydraulic structures.
- To make the student is expected to have thorough knowledge on the selection of turbines and pumps for practical purposes.

Text and Reference Books:

- Hydraulics and Fluid Mechanics including Hydraulic Machines by P. N. Modi and S. M. Seth; Standard Book house, New Delhi,2009.
- Kumar D S, "Fluid Mechanics", S. K. Kataria & Sons Publishers, New Delhi, 1998.
- Fluid Mechanics by A. K. Jain; Khanna Publishers, Delhi, 2008.
- Flow in Open channels by K. Subramanya, 3rd Edition, Tata McGraw-Hill,2008.
- Fluid Mechanics and Hydraulic Machines by R. K. Bansal,9th Edition, Laxmi Publications, 2011.

Departmental Electives:
Elective- IV & V (Eighth Semester)

CEPE-432 **Bridge Engineering** **3 0 0 3**

Course Objectives

- To equip the students with a thorough understanding of the behavior and design of bridges including decks, wing walls, abutments, girders, bearings and foundations.
- To understand various applied loads, such as truck load, impact, horizontal braking/centrifugal forces, wind and seismic loads.
- To develop an understanding of and appreciation for basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
- To help the student develop an intuitive feeling about the sizing of bridge elements, ie. develop a clear understanding of conceptual design.
- To carry out a design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements

Course Syllabus

Introduction: Definition, components of a bridge, classifications, importance of bridge

Investigation of Bridges: Need for investigations, selection of bridge site, preliminary data to be collected, design discharge and its determination, linear waterway, economical span, vertical clearance above HFL, scour depth, choice of bridge type.

Standard Specifications: For road bridges, I.R.C. loadings, code provisions on width of carriage way, clearances, loads considered etc. Standard specifications for railway bridges, Railway bridge code.

Reinforced Concrete Bridges: Slab culverts, T-beam bridge, Courbon's theory for load distribution, Balanced cantilever bridges, illustrative examples, pre-stressed concrete bridges, (General discussions).

Sub Structure: Types of piers and abutments, design forces, design of piers and abutments.

Bearing and Joints: Various types of expansion bearing and fixed bearings, elastomeric bearings, joints and their types. Introduction to construction, inspection and maintenance of bridges.

Course outcomes

- Understand the importance of bridges and its components.
- Knowledge of Indian code provisions for loading on bridges.
- Able to analyze and design different components of bridge.

- To get familiar with different types of bearings and their structural response.

Text and Reference Books:

1. Victor D J, “Essentials of Bridge Engineering” Oxford and IBH Publishers, New Delhi, 2003.
2. Ratwani V and Aswani M G, “Design of Concrete Bridges, Khanna Publishers, New Delhi, 1986.
3. Bindra S P, “Principles and Practice of Bridge Engineering” Dhanpat Rai & Sons, New Delhi, 1999.
4. Ponnuswamy S,” Bridge Engineering” Tata McGraw Hill, New Delhi, 2003.
5. Punmia B C , Jain A K ,”RCC Designs” Laxmi Pub.(P) Ltd.,2003.

CEPE-434 **Soil Dynamics** **3 0 0 3**

Course Objectives:

1. Identification of dynamic loads and their characteristic.
2. To apply theories of vibrations.
3. Able to determine dynamic soil parameters.
4. Understand the concept of Vibration isolation and screening.

Course Syllabus:

Introduction, Nature of Dynamic Loads; Theory of vibrations;

Dynamic Earth pressure and dynamic bearing capacity of shallow foundations; Liquefaction of Soils; Wave propagation in an elastic, homogeneous and isotropic medium; Determining dynamic soil parameters.

Machine foundations for reciprocating, impact type and Rotary machines; Vibration isolation and screening.

Course Outcomes:

- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations

- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Text and Reference Books:

1. Barken, D. D.,1962. Dynamics of bases and foundations. McGraw Hill, New York.
2. Saran, S., 1999. Soil Dynamics and Machine Foundations. Galogotia Publications Pvt. Ltd, New Delhi.
3. Rao, N. D. V. K., 1998. Vibration Analysis and Foundation Dynamics. Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi.
4. Krammer, S., 2003. Geotechnical Earthquake Engineering. Pearson Education Pvt. Ltd. New Delhi.
5. Prakash, S., 1981. Soil Dynamics. McGraw Hill Book Company, New York.

CEPE-436 Hydro Power Engineering 3 0 0 3

Course Objectives

- To provide the requirement of power and necessity of hydropower projects of all branches of Engineering.
- To know the structures like dams to generate the power
- To estimate the power as well as design of hydro power projects and its feasibility analysis.

Course Syllabus

Introduction: Waterpower Development – its types, distribution and use

World's largest hydropower generating plants, Estimate of flow rate and waterpower, Peak Load hydropower plants,

Dams: Classifications, types, site selection for dams.

Gravity Dams: Forces acting on gravity dams, Modes of failure, principal and shear stresses,

Elementary profile of a gravity dam, high and low gravity dams, profile of a dam from practical considerations, stability analysis methods.

Joints and galleries in gravity dams

Arch Dams: Types, methods for design of arch dam.

Buttress Dams: Types, forces acting on Buttress dam, stability analysis.

Spillways: Spillway capacity, classification of Spillways, Design of Ogee Spillway, Stilling Basins, Spillway crest gates.

Intake structures: functions, location, intake type, trash rack, dimension, design, spacing of bars, method of cleaning, shape of inlet, power canal, location, site, forebay, size, capacity, gates and valves.

Tunnels: geometric and hydraulic design, penstock, location, type, Economical diameter of penstock.

Surge tank: Functions, type, Design of Surge tank, methods of surge analysis, restricted orifice and differential surge tanks, downstream surge tanks.

Power House: Location, site and general arrangements, draft tubes, tail trace and their hydraulic design, turbines, number, make, size, type, characteristics and efficiency, pumps, Generators, exciters, switchboard, transformers and other accessories.

Course outcomes:

- To estimate flow rate and peak load of hydro power plants.
- Able to analyze and design of different types of dams. Knowledge of intake structures, their functions and applications.
- An understanding of general requirements and locations of power house and its components.

Text and Reference Books:

1. Barrows H K, "Water Power Engineering" Tata McGraw Hill Publishing Company Ltd. New Delhi, 1999.
2. Varshney R S, "Hydro Power Structures" Nem Chand & Bros., Roorkee, 2000.
3. Garg S K, "Irrigation Engineering and Hydraulic Structures" Khanna Publishers, New Delhi, 1998.
4. Galce A A, "Handbook of Dam Engineering" Van Nostrang Rheinhold Co., New York, 2000.
5. Justin J D and Creager W P, "Engineering for Dams" Vols. 1 to 3, John Wiley & Sons, New York, 1998.

CEPE-438 Software applications in Structural Engineering 3 0 0 3

Course Objectives

- To familiarize with graphic primitives, transformations and two dimensional and three dimensional drafting of computer graphics.
- To get practiced with computer methods of structural analysis.
- To understand the basic commands, principles and features behind commercially available software's.
- To utilize structural software for detailed analysis of complex structures.

Course Syllabus

Introduction: Software and software engineering, software metrics Estimation and planning.

System and Software Requirements Analysis: Computer based systems, computer systems engineering, system analysis, requirements analysis fundamentals, structured analysis and its extensions, object oriented analysis and data modeling.

Design and Implementation of Software: Software design fundamentals, data-flow oriented design, object oriented design, data oriented design methods, programming languages and coding.

Software Quality Assurance: Software quality and software quality assurance, software testing techniques, software Testing strategies, software maintenance, reverse engineering techniques.

Application Software in Civil Engineering: Introduction and application of softwars like STAAD III, STAAD PRO, ATENA, ADINA, ANSYS, DIANA, project work and application to practical problems.

Course outcomes

- To develop an understanding of different software's used in structural analysis.
- Able to do structural analysis of different types if structures in different software's.

Text and Reference Books:

1. Pressman R S, "Software Engineering A Practitioner's Approach" McGraw Hill International, New York, 2001.
2. Broeton P, "Software Engineering Environments" Wiley, New York, 2002.
3. Blum I B, "Software Engineering A Holistic View" Oxford University Press, 2001.
4. Blanchard B S and Fabrycky W J, "Systems Engineering and Analysis" Prentice-Hall International, New York1998.
5. Roy S K and Chakrabarty S, "Fundamentals of Structural Analysis with Computer Analysis & applications" S. Chand & Company, New Delhi, 2002.

CEPE-440 Ground Improvement and Ground Engineering 3 0 0 3

Course Objectives:

- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

Course Syllabus:

Introduction: The mechanics of soil stabilization, Principles and techniques.

Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.

Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electro-osmosis,lime column. soil-lime column. Grouting : permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems

Geosynthetics and Reinforced Soil Structures:Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences.

Course Outcomes:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization
- Students will learn about geosynthetics and their properties
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Text and Reference Books:

1. Swami, S., 2006. Reinforced Soil and Its Engineering Applications. I K International.
2. Shukla, S. K. and Yin, J. H., 2006. Fundamentals of Geosynthetics Engineering. Taylor and Francis.
3. Koerner, R. M., 2005. Designing with Geosynthetics. Prentice-Hall, N.J., U. S. A.
4. Rao, V. G. and Raju, N. S., 1999. Engineering with Geosynthetics. Tata McGraw Hill Publications,New Delhi.
5. Shukla, S. K., 2002. Geosynthetics and their Applications. Thomson Telford.

6. Han, J.,1964. Principles and Practices of Ground Improvement. John Wiley & Sons, Inc., New Jersey.

CEPE-444 Quantitative Methods in Civil Engineering 3 0 0 3

Course Objectives:

- Review the basic concepts of probability and statistics.
- To apply linear programming for optimization of various problems.
- To get familiar with queuing theory, decision theory and game theory.
- To get overview of modifications and improvement on CPM/PERT techniques

Course Syllabus:

Introduction and concepts of probability and statistics, Optimization through Linear programming- Need for linear programming, Linear programming model, dual problem, dynamic programming. Transportation model, solution of Transportation model, Assignment problems, solution of assignment problem. Queuing theory- waiting line models, deterministic model, probabilistic model, Decision theory- decision analysis, decision under uncertainty, Nature of Games, Games model, solution of Games model, simulations as applied to construction- simulation models, steps in simulation, Monte Carlo simulation. Modifications and improvement on CPM/PERT techniques.

Course Outcomes:

- Students will learn the basics of probability and statistics, linear programming for optimization, queuing theory, game theory and CPM/PERT tecniques

Text and Reference Books:

1. Verma, M., 1985. Construction Planning and Management Through System Techniques" Metropolitan Book Company, New Delhi.
2. Chitkara, K. K., 2000. Construction Project Management – Planning, Scheduling and Controlling. Tata McGraw Hill, New Delhi,.
3. O'Brien, J.,1999. CPM in Construction Management. McGraw Hill, New York.
4. Harris, R B. Precedence and Arrow Networking Techniques for Construction. John Wiley & sons, New York.
5. Levy, S., 2000. Project Management in Construction. McGraw hill, New York.

CEPE-446 Advanced Environmental Engineering 3 0 0 3

Course Objectives

- To make students familiar with other concepts in environmental engineering.
- To introduce the concept of sustainability and life cycle assessment

Course Content

Water Pollution: Natural treatment Systems, Classification, Treatment Mechanisms

Air Pollution: composition, air of occupied rooms, discomfort, indices of thermal comfort, comfort zones, air pollution sources, pollutant, metrological conditions, indications of air pollution, health & other aspects of air pollution, prevention & control disinfections of air.

Land Pollution: Introduction, Causes, Site Investigation, Risk Assessment

Sustainability: Concept, Life Cycle Assessment

Ventilation: Concept, standard of ventilation, types of ventilation.

Lighting: Requirements of good lighting, measurement of light, natural lighting, light measurement units, measurement of day light, artificial lighting, method of artificial illumination, lighting standards.

Noise Pollution: Definition, effect of noise, Exposure, noise control.

Radiation: Source of radiation exposure, type of radiation, radiation units, Biological effect of radiation, radiation protection.

Housing: Criteria for good housing, house standards, rural housing, housing & health over crowding.

Excreta Disposal: Public health, importance, extent of problem how diseases is carried from excreta, sanitation barrier, method of excreta disposal, excreta disposal in un-sewered area.

Course outcomes

The student will be able to:

- Understand the basic concepts of inter-relationship between different ecosystems with environment.
- Compute the causes of different types of pollution along with related regulations (local, national, and international).
- Explain the mechanisms of air pollutants transport/dispersion in the atmosphere and select the systems to control them at different sources.
- Prepare the life cycle assessment of Solid waste from its generation to disposal.
- Evaluate different methods of solid waste management and identify the suitable disposal alternatives available.

Text and Reference Books:

1. Garg, S.K., 2003. Environmental Engineering, Khanna publishers, New Delhi.
2. Rao, C.S., 2001. Environmental Engineering, McGraw Hill Book Company.
3. Metcalf and Eddy, 2003. Waste Water Engineering- Treatment Disposal and Reuse, Tata-McGraw Hill Publishing company limited, New Delhi.
4. Masters, G.M., Introduction to Environmental Engineering and Science, Prentice Hall of India, New Delhi.
5. Eckenfelder, W.W., 1989. Industrial Water Pollution control, McGraw Hill, New Delhi.

CEPE-448 Advanced Civil Engineering Materials 3 0 0 3

Course Objectives

- To make the students knowledgeable for different types of material used in construction works.
- To make the students understandableabout the properties of composite materials.
- To make the students familiar with design and prepare steel fibrous concrete

Course Syllabus

Plastics: Brief history, composition, polymerisation, classification of plastics, resins, Moulding compounds, Fabrication, properties of plastics, uses of plastics, PVC pipes in building.

Glass: General, properties, types and uses, special varieties of glass.

Timber: Characteristics, identification and uses of common Indian timber –teak, deodar, shisham, chil, sal, veneers, plywood, laminated boards-their uses and properties, uses and strength of bamboo, preservation of timber against fire and weather etc.

Miscellaneous Materials: Fly ash, Rubber –types, uses and properties, Heat insulating materials, Sound absorbent materials.

Steel: Market forms, properties of mild steel and hard steel, preventive measures for corrosion.

Composite Materials: Definition, classification – particulate composites, fibrous composites, properties of fibres and conventional materials.

Unidirectional composites: Introduction, volume fractions, weight fractions, longitudinal strength and stiffness, factors influencing longitudinal strength and stiffness, transverse strength and stiffness.

Short fiber composites: Introduction, modulus and strength of short fiber composites, rubber reinforced composites, Laminated composites - and its applications, Fiber reinforced plastics (FRP) and its applications

Mortars: Properties and uses of cement, lime and surkhi mortars, proportions, mixing, uses.

Steel fibrous concrete: Introduction, types of fibers, properties of steel fibrous concrete.

Course outcomes

- Knowledge of different types of material used in construction works.
- Understand the properties of composite materials.
- To design and prepare steel fibrous concrete

Text and Reference Books:

1. Agarwal B D and Broutman, L J, " Analysis and Performance of Fiber Composites" Wiley Interscience Publication, John Wiley & sons New York, 1980.
2. Rangwala S C, "Engineering Materials" Charotar Publishing House, Anand, 1985.
3. Weatherhead R G, "FRP Technology" Applied Science Publishers Ltd., London, 1998.
4. Raina K B, "Civil Engineering Materials" Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999.
5. Budinski K G, "Engineering Materials, Prentice Hall of India, New Delhi, 1985.

CEPE-450 Fluvial Hydrodynamics 3 0 0 3

Course Objectives:

- To understand the mechanism of sediment transport
- To get familiar with processes of flow in natural streams
- To know about flow structure in open channels

Course Syllabus:

Introduction to sediment: Physical properties of fluid and sediment, origin and properties of sediments, nature of problems.

Fluvial hydraulics: Scour criteria and problems: regimes of flow, Shields curve, incipient motion of sediment particles, terminal fall velocity of sediment in fluid, alluvial bed forms and Resistance to flow.

Sediment transport: Bed load, suspended load and total load transport, Meyer-Peter approach, du Boys' approach, Einstein's approach, Engelund and Fredsøe's approach, sediment samplers, design of stable channels, alluvial stream and their hydraulic geometry.

Turbulence in Open-Channel Flows: Decomposition and averaging procedure, equation of motion (Reynolds equations), Prandtl's mixing length theory, hypothesis of von Kármán, velocity distribution, the linear law in viscous sub-layer, the logarithmic law in turbulent wall shear layer, law in buffer layer, log-wake law and velocity defect law, turbulence intensity, calculation of bed shear stress using bed slope, velocity distribution, average velocity, Reynolds shear stress distribution, turbulent kinetic energy distribution.

River Training Works: Objectives, classification of river training works, design of guide banks, groynes or spurs their design and classification ISI Recommendations of approach embankments and afflux embankments, pitched islands, artificial cut-offs, objects and design considerations, river control-objectives and methods.

Sediment control: Silt management, management of canal in Punjab, Bhakra calal, delta formation.

Course Outcomes:

- Students should be able to evaluate the quantity of sediment transport in alluvial channels.
- Students should be able to analyze the flow structure on deformable boundaries.
- Students should be able to take initiative to protect the rivers by erosion and deposition.

Text and References:

Dey, Subhasish, "Fluvial Hydrodynamics" 2014, Springer, India

Garde, R.J., Raju, K.G.R, "Mechanics of Sediment Transportation and Alluvial Stream Problems" 1985, Wiley Eastern Ltd.

Yang, C.T., "Sediment Transport: Theory and Practice." 1996, McGraw-Hill, USA.

Yalin, M.S., "Mechanics of Sediment Transport" 1977, Pergamon Press, Oxford.

CEPE-452 Rural Roads 3 0 0 3

Course Objective:

- To understand the rural roads and the connectivity of road network.
- To understand the different parameter for geometrical design.
- To understand the low cost road design.

Introduction

Definition& distinctions between rural roads and highways, Indian scenario – road development plans ofGOI, PGMSY-phase I, II, III, and NRRDA

Geometric Design

Speed, typical cross-section, road width, camber, sight distance, longitudinal gradient

Structural Design

Traffic conditions, Assessment of sub-grade and construction materials, Design methodology specification, premises of rural roads

Construction

Equipment for construction, suitability of local construction materials for sub-base and base coarse, compaction of different layers, quality control

Stabilized soil roads

Use of lime, flyash, cement, bitumen etc - their influence on soils, advantages of agglomeration, OMC, MOD, CBR, conjugation methodology including curing

Course outcomes

- Describe awareness among the local available materials used in rural roads.
- Recognize Objectives of rural roads design and maintenance.

Text and Reference Books:

1) IRC-2010. "Rural Roads Manual", Indian Road Congress.
2) Indian Roads Congress (IRC) specifications: Guidelines and special publications on "Traffic Planning and Management", Indian Road Congress.
3) Guidelines of Ministry of Road Transport and Highways, Government of India.

Open Electives Courses for Other Departments

CEOE-370 Ecology and Environment 3 0 0 3

Course Objectives

- To inculcate the essentials of ecology and environment to the students of all branches of Engineering.
- To demonstrate the need of protecting environment
- To illustrate the concept of pollution through air, water and soil

Course Content

Ecology: introduction – Biosphere, scope, Ecosystem, population regulation, earth of organisms, relationships natural cycles – Hydrological cycle, carbon cycle, Nitrogen cycle, sulphur cycle, energy flow, forests & wild life, human activities.

Environmental Sanitation: Community Health – significance, disease transmission principles of Sanitation, vector control, housing needs, community sanitation measures, and health education.

Occupational safety: Hazards in various types occupation, objectives of occupational Health plan prevention and control.

Soil & Agricultural Pollution: Top soil, pollution, parameter of soil analysis, remedial measures, noise control ill effects, noise measurement, preventive & control measures.

Waste Water from Industries: Pollution – harmful effects, waste characteristics, mixing of industrial & domestic wastes. Pre-treatment of industrial waste – reduction of waste strength & volume equalization & neutralization. Case studies from two/three industries e.g. Dairy, Chemical and tanneries.

Metrology & Natural Purification Process: Scales of motion, heat, pressure, wind, moisture, relative humidity. Lapse rates & dispersion, pressure systems and dispersion, modeling.

Engineering System for Solid Waste Management: Solid waste generation, on-site handling, storage and proceeding, collection of solid wastes. Transfer & Transport, processing techniques, ultimate disposal.

Ventilation: Concept, standard of ventilation, types of ventilation

Environmental Management: Environmental impact Assessment, introduction project detail, Material flow analysis, Risk Assessment, Life cycle assessment.

Environmental Audit –Meaning of Environmental audit, audit items, audit procedure, safety audit.

Pollution Control Board – Legal aspects, court judgments, function of pollution control board.

Course outcomes

The students will be able to

- Understand the importance of ecology
- Appreciate the importance of protecting the environment
- Comprehend the complexities of the interaction among human being, animals, plants and the environment.

Text and Reference Books:

1) Canter, L.W., 1996. Environmental impact assessment. McGraw-Hill.
2) Davis, M.L. and Masten, S.J., 2004. Principles of environmental engineering and science. McGraw-Hill.
3) Rubin, H. S., 2001. Introduction to Engineering & Environment. Mc-Graw Hill.
4) Michael, P. N., 2016. Ecology. CBS Publishers.
5) Eckenfelder, W.W., 2000. Industrial Water Pollution Control. McGraw-Hill.
6) Peavy, R. and Rowe, D.R., Tchobanoglous, G., 1985. Environmental Engineering. McGraw Hill.
7) Allen, D. T., Shonnard, D. R., 2011. Sustainable Engineering: Concepts, Design and Case Studies. Prentice Hall.

CEOE-471 Disaster Management 3 0 0 3

Course Objectives

- To create awareness on disasters through intensive public education.
- To ensure disaster prevention, risk and vulnerability reduction, as a means of reducing the impact of disasters on society.
- To be in a position to provide the first line response in times of disaster.
- To assist in post-emergency rehabilitation and reconstruction effort.

Course Content

Natural Disasters - Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, Volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management - Preparedness through (IEC) Information, education & Communication Pre-disaster stage (mitigation), Effect to mitigate natural disaster at national and global levels. International strategy for disaster reduction,

Emerging approaches in Disaster Management-Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media.

Central, state, district and local administration, Armed forces in disaster response; Disaster response; Police and other organizations.

Course outcomes

The student will be able to:

- Identify various types of disasters, their causes, effects & mitigation measures.
- Demonstrate the understanding of various phases of disaster management cycle and create vulnerability and risk maps.
- Understand the use of emergency management system to tackle the problems.
- Discuss the role of media, various agencies and organisations for effective disaster management & preparedness for future through various case studies.
- Design early warning system and understand the utilization of advanced technologies in disaster management.

Text and Reference Books:

1. Khanna, B.K., 2005. Disasters: All you wanted to know about, New India Publishing Agency, New Delhi.
2. Edwards, B., 2005. Natural Hazards, Cambridge University Press, U.K.
3. Chakraborty, S.C., 2007. Natural Hazards and Disaster Management, Pargatishil Prokashak, Kolkata.
4. Sahni, P., 2002. Disaster Mitigation Experiences and Reflections, Prentice Hall of India , New Delhi.

CEOE-472 **Green Technology** **3 0 0 3**

Course Objective:

- To understand the sources of energy and present scenario in India.
- To understand the sustainable development through present and future energy system.
- To understand the different criteria for green building and green roads.
- To understand the basic of green chemistry.
- To understand the green nano-materials used in construction.

Course Curriculum

Energy sources: Introduction to nexus between Energy, Environment and Sustainable Development; Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Green Energy and sustainable development: The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development; global warming; greenhouse gas emissions, impacts, mitigation and adaptation ; future energy Systems- clean/green energy technologies; International agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC); sustainable development;

Green building and roads: Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Green Composites for buildings: Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment. Green roads and its construction procedure.

Green Chemistry: Introduction to Green Chemistry: Principles of Green Chemistry, Reasons for Green Chemistry (resource minimisation, waste minimisation, concepts), Green reactions solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts etc

Green Nanotechnology: Introduction to nanomaterials: Nanoparticles preparation techniques, Nanomaterials for "Green" Systems: Green materials, including biomaterials, biopolymers, bioplastics, and composites Nanotech Materials for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling.

Course outcomes

- Describe awareness among stakeholders and promote green agenda and green initiatives in their working environments leading to green movement.
- Recognize Objectives of Green building and roads.

Text and Reference Books:

1) Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A, 2nd Edition, John Wiley, 2006. "Energy and the Environment", ISBN: 9780471172482, Wiley, New York.
2) World Energy assessment, 2000. "Energy and the Challenge of Sustainability", UNDP, New York.
3) Nebojsa Nakicenovic, Arnulf Grubler and Alan McDonald, 1998. "Global Energy Perspectives", Cambridge University Press.
4) Robert Bent, 2002. "Energy: Science, Policy, and the Pursuit of Sustainability", ISBN13: 9781559639118, ISBN10: 1559639113, Island Press.
5) Jagadish K.S, Venkataramareddy B.U and Nanjundarao K.S, 2014. "Alternative Building Materials and Technologies", New Age International.
6) Ursula Eicker, 2009. "Low Energy Cooling For Sustainable Buildings", John Wiley and Sons Ltd.
7) Dennis C. Brewer, 2008. "Green My Home: 10 Steps to Lowering Energy Costs and Reducing Your Carbon Footprint", ISBN: 9781427798411, Kaplan Publishing.
8) James H.Clarke & Duncan Maacquarrie, 2002. "Handbook of Green Chemistry and Technology", Wiley-Blackwell.
9) Paul T.Anastas and John C. Warner, 2000. "Green Chemistry: Theory and Practice", Oxford University Press.
10) Loucas Tsakalakos, 2010. "Nanotechnology for Photovoltaics" ISBN: 9781420076745, CRC Press.
11) Dahl A, Maddux B.L.S, Hutchison J.E, 2007. "Toward Greener Nanosynthesis. Chemical Reviews", American Chemical Society.
12) Michael F, Ashby, Daniel L, Schodek, Paulo J, Ferreira, 2009. "Nanomaterials, nanotechnologies and design: an introduction for engineers", Elsevier.
13) Luis M. Liz-Marzán, Prashant V. Kamat, 2003. "Nanoscale materials", Springer.
14) Glen E. Fryxell, Guozhong Cao, 2007. "Environmental applications of nanomaterials: synthesis, sorbents and sensors", World Scientific Pub. Co. Inc.

Teaching scheme and syllabus for minor degree in Civil Engineering

Enclosure #2

CURRICULUM

3rd – 8th Semester July 2018 admission onwards

APPROVED BY

BOARD OF STUDIES (BOS)

12th MEETING, February 20th, 2019

Revised Teaching Scheme

(Minor Degree in Civil Engineering)

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

Phone: 0181-2690301, 02 (Ext. 2101, 2104), Fax: 0181-2690932 Website: www.nitj.ac.in

Twelve Theory Courses* for "Minor degree in Civil Engineering, for other Department students":

S. No.	Course No.	Course Title	L	T	P	Credits	Semester
1	CEMI-201	Highway and Traffic Engineering	3	1	0	4	III
2	CEMI-203	Surveying	3	0	0	3	
3	CEMI-205	Concrete Technology	3	0	0	3	
4	CEMI-211	Water Supply Engineering	3	0	0	3	
5	CEMI-202	Structural Analysis-I	3	1	0	4	IV
6	CEMI-208	Fluid Mechanics	3	1	0	4	
7	CEMI-301	Design of Concrete Structures-I	3	1	0	4	V
8	CEMI-303	Railway, Airport and Harbour Engineering	3	0	0	3	
9	CEMI-305	Soil Mechanics	3	1	0	4	
10	CEMI-302	Foundation Engineering	3	0	0	3	VI
11	CEMI-306	Design of Steel Structures-I	3	1	0	4	
12	CEMI-308	Elements of Earthquake Engineering	3	0	0	3	
13	CEMI-401	Design of Hydraulic Structures	3	0	0	3	VII
14	CEMI-402	Estimating and Costing	3	0	0	3	VIII

*For minor degree, student can complete any six courses out of these courses with the conditions: (i) that not more than one course from each semester can be taken up by a student to complete the requirements for his/her minor degree and, (2) the heads of both the departments will ensure that no courses are being repeated.

Syllabus
for
Minor Degree in Civil Engineering

IIIrd Semester

CEMI-201 **Highway and Traffic Engineering** **3 1 0 4**

Course Objectives

1. To give insight of the various facets of the Highway Engineering, importance and role of the transportation system as a whole and highway engineering vis-à-vis other modes of transportation.
2. To familiarize the learner with the historical development in the field of road construction right from ancient and medieval times upto the modern era, development taking place in the field of highway engineering in the Indian context including various agencies involved in the highway engineering and the roles being played by them.
3. To familiarize the learner with the various studies required for the highway planning and alignment and location surveys along with other allied surveys, preparation of the report for highway projects
4. To familiarize the learner to understand the phase of engineering which deals with the planning, analysis and design of the geometric features of the streets, geometrics design of streets, highways, abutting land and with traffic operations thereon w.r.t. safe, convenient and economic transportation of people and goods.
5. To familiarize the learner about the various traffic surveys / studies required to be conducted for collecting, processing, analyzing the data and interpretation of the results thereof for planning and designing the geometric features of the streets, highways and planning the transportation network or systems or component thereof.
6. To enable the learner to study the properties of the different materials to be used in the construction of highways and other allied structures, characterize the materials and evaluate their suitability for application in construction.
7. To make the leaner understand about the classification and behaviour of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements and the design of pavements.
8. To familiarize the learner about the construction of various types of road pavements, distresses in pavements; and maintenance and rehabilitation of pavements.

Course Curriculum

Introduction: Importance and role of transportation systems; different modes of transportation, historical development of road construction , brief history of road development in India; overview of various roads development programmes in the country and present status thereof, different programmes being exceuted by the various agencies, classification of roads according to different criteria.

Highway Planning, Alignment and Surveys

Various surveys for planning of the highway, highway alignment, basic requirements of an ideal alignment, factors governing the alignment, different types of surveys for locating highway.

Highway Geometric Design: Factors governing the design of geometric features, cross-sectional elements, camber, sight distance-definition analysis of stopping sight and passing sight distances, passing zones. Design of horizontal alignment-super elevation. Extra widening on curves, transition curves. Design of vertical alignment, gradients, types of vertical curves and their design

Traffic Engineering-Traffic Engineering studies (speed, volume, O & D, parking and accident studies), traffic signs, traffic signals, road markings, road intersection, highway lighting.

Highway Materials: Different materials for subgrade, sub-base, base course and surface/ wearing course, desirable properties of these materials for different types of pavements, various tests to be conducted for evaluating their suitability as an highway construction materials, requirements as per codal provisions

Pavement Design:

Different types of pavements, comparison between them vis-à-vis based on the structural behaviour and other parameters, factors affecting design of pavements, Various approaches of designing the pavement and methods falling under each category, analysis and design of pavement (flexible and rigid) using IRC method.

Highway Construction, Distresses and Maintenance: Construction of different types of pavements (flexible and rigid, Semi-rigid, composite, etc.), low cost and low volume roads, stabilized roads, bituminous surface treatment, etc.; distresses (failure) in pavements, maintenance including strengthening of the pavement.

Course Outcomes

Upon the successful completion of the course, the leaner shall be able to:

1. Know the various modes of transportation, their significance in the nation’s building.
2. Know the development taking place in the field of highway construction until recent time.
3. Know the development in the field of highway engineering in the country and the present status thereof along with the role played by various agencies in the field.
4. Know different studies required to be carried out for highway planning, factors to be considered for highway alignment; and various surveys to be carried out for highway alignment along with the project preparation.
5. Know the cross-section elements of highway or road, different geometric features of the highway, factors affecting the design of the geometric features.

6. Understand the analysis and design of geometric features of the highway.
7. Be familiarized with different traffic studies/ surveys required to be carried out for the planning of the transportation network/ transportation system and geometric design of the streets and highways.
8. Understand as to how to conduct the traffic surveys and analyze the data to be used in the transportation/ traffic planning and geometric design.
9. Understand the properties of the various materials to be used in the construction of different types of pavements/ roads, their characterization and suitability for utilization in the construction.
10. Study the factors affecting the design of different types of pavement and analyze and design the pavements.
11. Know the construction of different types of roads/ pavements including the technique and procedure, failures in different types of pavements, maintenance and rehabilitation thereof.

Books Recommended:

i) Khanna, S.K., Justo, C.E.G. and Veeraragavan, A. 2014. Highway Engineering. Nem Chand and Bros., Roorkee (Revised 10th Edition)

ii) Kadiyali, L.R. and Lall, N.B., 2005. Principles and Practice of Highway Engineering. Khanna Publishers, Delhi.

iii) Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering. CBS Publishers and Distributors.

iv) Sriniwaskumar, R.A., 2013. Text Book of Highway Engineering. University Press, Hyderabad.

v) Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering. University Press, Hyderabad.

vi) Rao, G.V., 2000. Principles of Transportation and Highway Engineering. Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.

vii) Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering). S. Chand and Company Pvt. Ltd., New Delhi.

viii) Chakraborty, Partha and Das, Animesh, 2013. Principles of Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi

Reference Books:

1. Kandhal, Prithvi Singh, 2016. Bituminous Road Construction in India:; PHI Learning Pvt. Ltd., Delhi
2. Papacostas, C.S. and Prevedouros, P.D., 2012.Transportation Engineering and Planning. Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Khisty, C.J. and Lall, Kent, B. 2018. Transportation Engineering. Prentice Hall India Learning Pvt. Ltd., New Delhi.

4. Srinivasakumar, R., 2015. Pavement Design. University press, Hyderabad (First Published 2013; Preprinted in 2015).

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Planning related aspects in the context of Highway Geometrics/ Traffic Planning/ Pavement Design and Highway Construction).

Note: Some of the recent specifications may not have been incorporated in few books. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes shall be referred to.

CEMI-203 Surveying 3 1 0 4

Course Objectives

- At the end of the course the student wills possess the knowledge about Chain surveying, Compass surveying, Plane table surveying, Levelling, Theodolite surveying and Engineering surveys.
- To apply knowledge of mathematics, science, and engineering to understand the measurement techniques and equipment used in land surveying.
- Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

Introduction: Definition, classification of surveys, principle, distorted or shrunk scales, precision in surveying. Different type of surveying: Chain Surveying, Compass Surveying and Plane Table Surveying.

Levelling: Definitions of terms used in levelling, different types of levels, parallax, adjustments, bench marks, classification of levelling, booking and reducing the levels, rise and fall method, line of collimation method, errors in leveling, permanent adjustments, corrections to curvature and refraction, setting out grades, longitudinal leveling, and profile leveling. Automatic Levels.

Contouring: Definition, representation of reliefs, horizontal equivalent, contour interval, characteristics of contours, methods of contouring, contour gradient, Interpolation of contours, uses of contour maps. Contouring by using total station and theodolite.

Hydrographic Surveying: Objects, applications, Establishing controls, Shore line survey, Sounding, Sounding Equipment, Methods of locating soundings - conventional and using GPS , Reduction of soundings, Plotting of soundings, Nautical Sextant and its use, Three point problem and its use, solution of three point problem by all methods, Tides and tide gauges, determination of MSL.

Remote Sensing and Geographical Information System:

Remote Sensing Introduction and definition, Necessity, importance and use of remote sensing, Difference between Aerial photograph and satellite image, Manual & digital image interpretation, Elements of visual image interpretation such as size, shape, tone, texture, etc. Field verification or Ground truthing. Advantages and limitations of RS, Different applications of RS- (Land use and land cover mapping, Disaster management Flood & Earth Quake, and Resource Inventory management,) Digital Image processing, its objectives and different steps in it. Introduction to LIDAR & Underground utility Survey.

Geographical Information System -Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management, querry & analysis and visualization) of GIS. Coordinate systems and projections, Georeferencing, GIS data - spatial (Raster & vector) & a spatial data.

Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of a spatial data. Applications of GIS such as Visibility analysis, Slope analysis, Watershed analysis. & Preparation of thematic maps. Limitations of GIS.

Course outcomes

- Knowing the concept of survey, its classification and principle.
- To learn the different methods of surveying and their applications.
- Understood the errors in traversing, their propagation and adjustment.
- Able to book and reduce field observations.
- Able to use advance equipment like total station, GPS etc. for traverse measurements.
- Understood the use of astronomy in surveying and measurements from aerial photographs.

Text and Reference Books:

1) Punmia B.C, 2018. "Surveying" Vol.1, Laxmi Publications Pvt. Ltd., New Delhi.
2) Punmia B.C, 2018. "Surveying" Vol.2, Laxmi Publications Pvt. Ltd., New Delhi.
3) Kanetkar T.P and Kulkarni S.V, 2016. “Surveying and leveling” Vol. I, VGP, Pune.
4) Kanetkar T.P and Kulkarni S.V, 2016 “Surveying and Leveling” Vol. II, VGP, Pune.
5) Basak N N, 2017. “Surveying and leveling”, Tata McGraw Hill, New Delhi.

6) Agor R, 1991. "Advance Surveying" Khanna Publishers, New Delhi.

7) Venkataramiah C, 2011. "A Text Book of Surveying" University Press, Hyderabad.

8) Alfred Leick , 2003. “GPS Satellite Surveying”, Wiley.

9) Chandra A.M and Ghosh S.K, 2015. “Remote sensing and Geographical Information System”, Alpha Science International Ltd.

10) Bhatta.B, 2011. “Remote Sensing & GIS”, Oxford University Press.

11) Burrough P.A, Mcdonnel R.A and Lloyd C.D, 2015. “Principles of Geographical Information System”, Oxford University Press.

12) Satheesh Gopi, R.Sathikumar and N. Madhu, 2017. “Advanced Surveying -Total Station, GIS and Remote Sensing”, Pearson publication.

CEMI-205 **Concrete Technology** **3 0 0 3**

Course Objectives

- To provide awareness regarding concrete as a structural material.
- To make students knowledgeable about the materials used to make concrete; including their sources, production and properties.
- To provide knowledge regarding designing of normal concrete mixes.
- To make students aware of understanding of various properties of concrete in fresh and harden state.

Course Syllabus

Introduction: Concrete as a Structural material, constituent materials of concrete.

Cement: Types of cements, basic chemistry, heat of hydration, Testing of cement: Fineness, consistency, setting times, strength, types of Portland cements, expansive cements, pozzolanas.

Aggregates: Classification of aggregates, Mechanical properties: Bond, strength, toughness, hardness, physical Properties, Specific Gravity, Bulk density, porosity and absorption, Moisture content, bulking of sand, sieve analysis, fineness modulus, grading of aggregate, maximum aggregate size.

Mix Design: Factors to be considered: water/cement ratio, durability, workability, cement and aggregate content, Design of mix by IS Code Method.

Physical Properties of Fresh Concrete: Workability: factors affecting, methods of determination of workability, Density of fresh concrete.

Mixing, Handling, Placing & compaction of concrete: Mixers, mixing time, ready mixed concrete, pumped concrete, vibration of concrete, internal & external vibrators, re-vibration, shotcrete.

Strength of concrete: Porosity, Gel/space ratio, Total voids in concrete, factors affecting strength: Water/cement ratio, relation between tensile & compressive strengths; bond to reinforcement.

Permeability and Durability: Permeability, sulphate attack, action of frost, frost resistance concrete.

Course outcomes

- Introduction of concrete as a structural material.
- Describe the materials used to make concrete; including their sources, production and properties.
- Knowledge of designing of normal concrete mixes.
- An understanding of various properties of concrete in fresh and harden state.

Text and Reference Books:

1. Neville A M and Brookes J J, "Concrete Technology" Pearson Publishers, New Delhi,1994.
2. Neville A M, "Properties of Concrete" Pearson Publishers, New Delhi, 2004.
3. Gambhir M L, "Concrete Technology" Tata McGraw Hill, New Delhi, 1995.
4. Shetty M S, "Concrete Technology" S. Chand & Company, New Delhi, 2002.
5. Mehta P K,"Microstructure of Concrete" Indian Concrete Institute and ACC, Bombay, 1997.

CEMI-211 Water Supply Engineering 3 0 0 3

Course Objectives

- To make the students learn about technical aspects of drinking water treatment and distribution in an integrated way.
- To make the students pay attention to the choice of technologies and tools for water supply, ranging from low cost to advanced options.

Course Content

Public Water Supply: Beneficial uses of water, water demand, per capita demand, variation in demand, causes detection and prevention of wastage of water, population forecasting.

Sources of Water Supply: Surface and underground sources, relation and development of source in r/o quality and quantity of water, development of wells. Storage reservoir balancing and service storage, capacity determination by

mass curves method. Intake and transmission system: distribution systems: network design. Hydrology principles, zones of under-ground water.
Quality and Examination of Water: Necessity for examination of water impurities in water. Sampling of water, physical, chemical & bacteriological quality for domestic water supply. Drinking water quality standards and criteria.
Water Supply and Drainage of Buildings: System of water supply house connections, metering, internal distribution, sanitary fittings, pipe joints, different types of pipes and pipes materials.
Water Treatment: Unit operations in water treatment, screening, plain sedimentation tank and its theory, sedimentation, aided with coagulation, design of sedimentation tank, flocculation sand filtration, rapid gravity filter, pressure filters, disinfections; Necessary; requirements of a disinfectant, methods, of disinfecting, different practices of chlorination.
Miscellaneous Methods of Water Treatment: Aerial colour, odors & Taster from water, control, removal of iron & manganese from water softening processes, base exchange process, swimming pool water treatment.

Course outcomes

The student will be able to:

- Identify different types of water demands and select suitable source of water.
- Predict future population and estimate future water demands.
- Demonstrate a firm understanding of various water quality parameters.
- Design different water treatment units to meet the drinking water quality standards and criteria.
- Plan and design the water transportation, pumping stations and pipe network .
- Design low cost water treatment techniques in the rural areas.

Text and Reference Books:

1. Garg, S.K., 2003. Water Supply Engineering Vol. I, Khanna Publishers, New Delhi.
2. Raju, B.S.N., 1997. Waste and Wastewater, Tata McGraw Hill, New Delhi.
3. Peavy, H.S. and Rowe, D.R., 2003. Environmental Engineerin, McGraw Hill, New Delhi.
4. Birdie, G.S., 2003. Water Supply & Sanitary Engineering, Dhanpat Rai Publications, New Delhi.

IVth Semester

CEMI-202 Structural Analysis-I 3 1 0 4

Course Objectives

- Ability to idealize and analyze statically determinate and indeterminate structures.
- Familiarity with structural analysis software.
- Familiarity with professional and contemporary issues.
- To introduce the students to concept of global structural stability, theory of structural analysis, and methods in structural analysis.

Course Syllabus

Introduction: Need of analysis, techniques of structural idealization, basic tools of analysis, reactions in structure, notations and sign conventions, free – body diagrams, static determinacy, stability of structures, principle of superposition, loads on structures.

Plane Trusses: Introduction, member arrangement in a truss, stability and determinacy, roof and bridge trusses, analysis of trusses, notations and sign conventions, equations of condition, zero load test, classification of trusses.

Deflection of Beams: Introduction, direct integration method, moment – area method, conjugate beam method, Principle of virtual work, unit load method, Betti's law, Maxwell's law, Castigliano's theorem.

Combined Bending and Axial Loads: Introduction, limit of eccentricity for no tension in the section, core of the section, middle third rule, wind pressure on chimneys, forces on dams.

Rolling Loads Introduction to rolling loads and influence lines, Determination of shear force, bending moment at a section and absolute shear force and bending moment due to single point load, uniformly distributed load, several point loads etc.

Influence lines: Introduction, moving loads, influence lines, influence lines for reactions, shear force and bending moment, influence lines for beams, girders with floor beams, trusses and arches, absolute maximum B. M. & S. F, Muller Breslau Principle

Arches: Introduction, curved beams, arch versus a beam, three hinged arch, moment, shears and normal thrust in three hinged arches

Cables and Suspension Bridges: Introduction, shape of a loaded cable, cable carrying point loads and UDL, cables with ends at different level, cable subjected to temperature stresses, suspension bridge with two hinged and three hinged stiffening girders, influence lines.

Statically determinate space Trusses:

Concurrent forces in space, moment of force, constraint of point in space, tension coefficient method, simple space trusses, method of sections.

Course outcomes

- Understand the need of analysis, techniques of structural idealization, basic tools of analysis.
- Analysis of statically determinate structural systems.
- Concept of deflection of beams.
- Understand the concept of rolling loads and/or reactions, support displacements and on the structures.
- Analysis of statically determinate plane and space trusses.
- Able to draw the influence lines of beams, trusses, girders and arches.

Text and Reference Books:

1. Utku S, Norris C H and Wilbur J B, "Elementary Structural Analysis, McGraw Hill, New York, 1990.
2. Jain A K, "Elementary Structural Analysis" Nem Chand & Brothers, Roorkee, 1990.
3. Reddy C S , "Basic Structural Analysis" Tata McGraw Hill, New Delhi, 2003.
4. Hibbeler C, "Structural Analysis" Pearson Publishers, New Delhi, 2002.
5. Punmia B C, Jain A K and Jain A K "Theory of Structures" Luxmi Publications, 2000.

CEMI-208 **Fluid Mechanics** **3 1 0 4**

Course Objectives:

- To inculcate the understanding of fluid and it behavior.
- To provide the students an illustration of the significance of the fluid in Civil Engineering Profession.
- To illustrate the fluid analysis over different bodies and medium

Course Syllabus:

Laminar Flow: Navier-stokes equations in cartesian coordinates (no derivation), meaning of terms, flow between parallel plates, stokes law, Flow through porous media, Transition from laminar to turbulent flow.

Boundary Layer Analysis: Assumptions and concept of boundary layer theory, Boundary layer thickness, displacement momentum & Energy thickness, laminar and Turbulent boundary layers on a flat plate, Laminar sub-layer, smooth and rough boundaries, Local and average friction coefficients, Separation and control.

Turbulent Flow: Definition of turbulence, scale and intensity, Effects of turbulent flow in pipes, Equation for velocity distribution in smooth and rough pipes (no derivation), Resistance diagram.

Flow past immersed bodies: Drag and lift, deformation Drag and pressure drag, Drag on a sphere, cylinder and Airfoil, lift-Magnus Effect and circulation, lift on a circular cylinder.

Uniform flow in open Channels: Flow classifications, basic resistance, Equation for open channel flow, Chezy, Manning, Bazin and kutter formulae, Variation of roughness coefficient, conveyance and normal depth, Velocity distribution, Most efficient flow sections- Rectangular, trapezoidal and circular.

Energy and Momentum Principles and Critical Flow: Energy and specific Energy in an open channel; critical depth for rectangular and trapezoidal channels. Alternate depths, applications of specific Energy to transitions and broad crested weirs. Momentum and specific force in open channel flow.

Gradually Varied Flow: Differential Equation of water surface profile; limitation, properties and classification of water and surface profiles with examples. Computation of water surface profile by graphical, numerical and analytical approaches.

Hydraulic Jump and Surges: Theory of Jump, Elements of jump in a rectangular channel, length and height of jump, location of jump, Energy dissipation and other uses. Surge as a moving hydraulic jump. Positive and negative surges.

Course outcomes:

- An understanding of fluid mechanics fundamentals, including concepts different types of flows and their principles.
- Knowledge of laminar and turbulent boundary layer fundamentals.
- An understanding of energy and momentum principles.
- Computation of water surface profile by graphical, numerical and analytical approaches.

Text and Reference Books:

1. Massey B S, "Mechanics of Fluids" ,ELBS, Van Nostrand Reinhold Co. Ltd., U. K, 1998.
2. Streeter V L, Wylie E B and Bedford K W, "Fluid Mechanics" McGraw Hill, New York, 2001.
3. Kumar D S, "Fluid Mechanics", S. K. Kataria & Sons Publishers, New Delhi, 1998.
4. Subramanya K, "Theory and Application of Fluid Mechanics" Tata McGraw Hill, New Delhi 2001.
5. White F M, "Fluid Mechanics" McGraw Hill, New York, 1997.

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Vth Semester

CEMI-301 Design of Concrete Structures-I 3 1 0 4

Course Objectives

- Be able to perform analysis and design of reinforced concrete members.
- Be able to identify and interpret the appropriate relevant industry design codes.
- To become familiar with professional and contemporary issues in the design and fabrication of reinforced concrete members.
- To be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.

Course Syllabus

Introduction: Plain and Reinforced Concrete, Objectives of design. Structural systems. Introduction to design philosophies.
Analysis of Beams: Working Stress Method, Assumptions made in theory of reinforced concrete construction, moment of resistance of singly, doubly reinforced and flanged beams.
Limit State Method: Assumptions in analysis, Analysis of singly and doubly reinforced rectangular sections, Analysis of singly reinforced flanged sections.
Design of Beams for flexure: Codal provisions for design as per IS 456:2000 according to working stress and limit state method, Design of singly and doubly reinforced sections, Design of flanged sections.
Design for Shear, Bond & Torsion: Shear Stresses in homogeneous rectangular beams, critical sections, design shear strength of plain concrete, Design of shear reinforcement, Bond stress, Anchorage development length, bond failure & bond strength,
Introduction to torsion in R. C. C. beams, General behaviour in torsion, Design of sections subjected to torsion, shear and flexure.
Design of Slabs: One-Way and two-way slabs. Design of slab sections using IS method. Introduction to flat slabs.
Design of Continuous beams and slabs: Analysis of continuous systems General guidelines & Codal provisions design and detailed drawings of continuous beams and slabs.
Design of columns: Classification and effective length of columns, codal requirements, Analysis and design of sections subjected to axial loading and axial loading combined with bending moment.
Design of Isolated Footings: Types of footings, soil pressure under footings, General design considerations and Codal provisions. Design of isolated, square, rectangular and circular footings. Design of footings subjected to eccentric loads.
Staircases: Types of staircases, loads on stairs, Design of different types of staircases.

Course outcomes

- To learn about the reinforced concrete, its properties.
- To learn about different design philosophies for design of concrete structures.
- To carry out analysis of beams.
- Understand the limit state method of design of rcc members.
- Knowledge of design provisions given in Indian standard code.
- To design the various members like beams, slabs, columns, footings etc with limit state design method.

Text and Reference Books:

1. Pillai U. and Menon D., “Reinforced Concrete Design” Tata McGraw Hill, New Delhi 2003.
2. Jain A.K., “Limit State Design of R. C. C. Structures” Nem Chand & Sons, Roorkee 2002.
3. Varghese “Limit State Design of Reinforced Concrete” Prentice Hall of India, New Delhi 2003.
4. Dayaratnam P., “Design of Reinforced Concrete” Oxford & IBH Publishers, New Delhi 2002.
5. Chandra R., “Limit State Design of Reinforced Concrete” Standard Book House, New Delhi 2002.

CEMI-303 Railway, Airport and Harbour engineering 3 0 0 3

Course Objectives

- Students should be able to relate their understanding of the railroad industry, history, and principal components.
- Finding out the traffic load analyzing them and designing transportation systems.

Course Syllabus

Railway Introduction: History of development of Railways, Permanent Way, Requirement of ideal permanent way, cross-sections of single and double tracks in embankment and cutting.

Rail & sleepers: Component Parts of RailwayTrack, Gauges, Resistances to Traction and Stresses in Track, Various Resistances and Their Evaluation, Hauling Capacity and Tractive Effort, Stresses in Rail, Sleepers, Coning of Wheels, Creep, Wear, Joints in Rails, Sleeper Types, Rail Fittings and Fixtures: welding, rail to rail connection, rail to sleeper connection, bearing plates and chairs

Geometric design of railway: Geometric Design, Track Alignment, Horizontal Curves, Super Elevation, Equilibrium Cant and Cant Deficiency, Transition Curves, Vertical Curves-Gradients and Grade Compensation

Points and Crossing: Simple types currently in use: points and crossing terminology, layout plans of simple cross over, turnouts, diamond crossing, Geometric design of a simple turn out design of crossings & switches.

Signaling and Interlocking: Objects of signaling, types of signals, Interlocking and devices used in interlocking.

Airport Introduction: Airport classification, classification of flying activities. Characteristics & airport size.

Airport Planning: Types of runway patterns, Running layout effect of metrological conditions, wind rose, specifications for runway clearances and other airport utilities, Airport Site Selection, Airport Obstructions, Zoning, Classification of Obstructions, Imaginary Surfaces, Approach Zone and Turning Zones,

Runway & Taxiway Design: Airport Capacity, Loading Apron, Service Hanger, Taxiway Design, Introduction to Airport Pavement Design.

Docks and Harbours: Definition, location & layout of docks, classification of docks Simple description, frequent dealing with natural and artificial harbour, their classification & requirement, action of wind, water, tides and lateral drift on harbour structures.

Courseoutcomes

- Knowledge of history of development of railways.
- Understand the working of different elements of railway track.
- Understand the airport planning for efficient development of airports.
- To get familiar with docks and harbours, their classification and requirement.

Text and Reference Books:

1) Rangawala, S. C., 2002. Railway engineering. Charotar Publishers, Anand.
2) Arora, S. P., and Saxena, S. C., 2001. Railway engineering. Dhanpat Rai Publishers, New Delhi.
3) Khanna, S. K., Arora, M. G. and Jain, S. S., 2002. Airport planning & design. Nem Chand & Bros., Roorkee.
4) Srinivasan, R. and Rangwala, S. C., 1999. Harbours. Charotar Publishers, Anand.

CEMI-305 **Soil Mechanics** **3 1 0 4**

Course Objectives

1. To understand origin of soil, different types.
2. Knowledge of different index properties of soil.
3. Study of classification of fine grained and coarse grained soils.
4. To understand the concept of compaction and consolidation of soil.
5. Understand the shear strength of soil and its engineering importance and application.

Course Syllabus

Basic Concepts: Definition of soil and soil mechanics common soil problem in Civil Engineering field. Principal types of soils. Important properties of very fine soil i. e. adsorbed water, base exchange and soil structure. Characteristics of main clay mineral groups. Basic definitions in soil mechanics. Weight volume relationship physical properties of soils.

Index Properties: Determination of Index properties, classification of coarse grained soils and fine grained soils.

Permeability and seepage: Concept of effective stress principle. Seepage pressure, critical hydraulic gradient and quick sand condition, Phreatic Line. Capillary phenomenon in soil. Darcy's law and its validity seepage velicity. Co-efficient of permeability and its determination average permeability of striated soil mass Factors affecting 'K' and brief discussion.

Compaction: Definition and object of compaction and concept of O.M.C. and zero Air Void Line. Modified proctor test. Factors affecting compaction. Effect of compaction on soil properties and their discussion. Field compaction methods their comparison of performance and relative suitability. Field compactive effort. Field control of compaction by proctor needle.

Consolidation: Definition and object of consolidation difference between compaction and consolidation. Concept of various consolidation characteristics i.e. a_v, m_v and C_v primary and secondary consolidation. Terzaghi's method for one-dimensional consolidation. Consolidation test. Determination of C_v from curve fitting methods. Normally consolidated and over consolidated clays importance of consolidation settlement in the design of structures.

Stress Distribution: Boussinesq's equation for a point load, uniformly loaded circular and rectangular area, pressure distribution diagrams. New marks chart and its construction. Two- to – one method of load distribution. Comparison of Bossinesq and Westerguard analysis for a point load. Limitations of elastic formula.

Shear Strength: Stress analysis of a two - dimensional stress system by Mohr circle. Concept of pole. Coulomb's law of shear strength Coulomb - Mohr strength theory. Relations between principle stresses at failure Shear strength tests. Derivation of Skempton's pore pressure parameters. Stress strain and volume change characteristics of sands.

Course outcomes

- The students will be able to understand the origin of soil and will have the knowledge of different index properties
- They will be able to classify soil and understand the engineering behaviour of soil

Text and Reference Books:

1. Holtz, R.D. and Kovacs, W.D., 1981. An Introduction to Geotechnical Engineering. Prentice Hall.
2. Ranjan, G. and Rao A.S.R., 2000. Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
3. Murthy V N S., 2001. Principles of Soil Mechanics and Foundation Engineering. UBSPD.
4. Das, B.M. 2002. Principles of Geotechnical Engineering. Cengage Pulishers
5. Lambe, T.W. and Whitman, R.V., 2000. Soil Mechanics. John Wiley and Sons
6. Couduto, D.P., 2002. Geotechnical Engineering – Principles and Practices", Prentice Hall of India.

VIth Semester

CEMI-302 **Foundation Engineering** **3 0 0 3**

Course Objectives

1. To provide knowledge base on the current practices in foundation engineering to carry out the job of selection, design and construction of foundations.

2. To study the earth pressure theories.
3. To carry out the soil investigation and study of methods involved in it.
4. Understand the significance and determine the load bearing capacity for shallow and deep foundations.
5. To carry out analysis and design of pile foundation and machine foundation.
6. Understand the concepts of stability of slopes.

Course Syllabus

Earth Pressure: Terms and symbols used for a retaining wall. Movement of wall and the lateral earth pressure. Rankine's and Coulomb's theory for lateral earth pressure. Culmann's graphical construction and Rebhan's graphical construction.

Arching in soil and Braced Cuts: Theory of Arching, Braced excavations, Deep cuts in sand, saturated soft to medium clays.

Soil Investigation: Object of soil investigation for new and existing structures. Depth of exploration for different structures. Spacing of bore holes. Methods of soil exploration and relative merits and demerits. standard penetration test, dynamic cone penetration test, static cone penetration test, field vane shear test, large shear box test, field permeability test, Geophysical Tests, Dynamics properties of soil planning of soil exploration programme.

Shallow Foundation: Types of shallow foundations, definitions Terzaghis analysis. Types of failures. Factors affecting bearing capacity. Skemptons equation. B. I. S. recommendations for shape, depth and inclination factors. Plate Load Test and Standard Penetration Test. Contact pressure distribution. Causes of settlement of structures comparison of immediate and consolidation settlement Calculation of settlement by plate load test and Static Cone Penetration Test data. Allowable settlement of various structures according to IS Code. Situation most suitable for provision of rafts. Proportioning of rafts in sand and clays. Various methods of designing raft. Floating foundation.

Types of foundations, selection of type of foundation, basic requirements of a foundation, computation of loads, Design steps.

Pile Foundation : Necessity and uses of piles, classification of piles. Merits and demerits of different types based on composition. Types of pile driving hammers & their comparison. Effect of pile driving on adjacent ground. Use of Engineering news formula and Hiley's formula for determination of allowable load. Pile Load Test, separation of skin friction and point resistance using cyclic pile load test data. Related Numerical problems. Determination of point resistance and frictional resistance of a single pile by static formula. Piles in clay, safe load on a friction and point bearing pile. Pile in sand spacing of piles in a group, factors affecting capacity of a pile group. Efficiency of pile group bearing capacity of a pile group in clay. Settlement of pile groups in clay and sand Negative skin friction.

Stability of Slopes: Necessity, causes of failure of slopes. Stability analysis of infinite and finite slopes in sand and clay. Taylor's stability number and its utility.

Caissons and wells: Major area of use of caissons Advantages and disadvantages of open box and pneumatic caissons. Essential part of a pneumatic caisson. Components of a well.

Machine Foundations: Theory of vibrations, foundations subjected to vibrations, determination of dynamic properties of soil, Dynamic analysis of block foundations.

Course outcomes

- The students will be able to select the correct foundation for the structure, calculate the bearing capacities
- They will be able to determine the stability of slopes, calculate lateral earth pressures

Text and Reference Books:

1. Ranjan, G. and Rao A.S.R., 2000. Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
2. Murthy V N S., 2001. Principles of Soil Mechanics and Foundation Engineering. UBSPD.
3. Das, B.M. 2004. Principles of Foundation Engineering. Cengage Pulishers
4. Couduto, D.P., 2002. Geotechnical Engineering – Principles and Practices", Prentice Hall of India.

CEMI-306 Design of Steel Structures-I 3 1 0 4

Course Objectives

- To make students aware about different types of steel joints and their design.
- To share knowledge of design provisions given in Indian standard code.
- To make students aware about the concepts of basic elements like, tension and compression members, column bases, plate girder.
- To provide knowledge about the analysis and design the roof trusses.

Course Syllabus

Joints: Introduction to different joints,Stresses in bolts, strength and failure of bolted joints, Types of welds and welded joints, stresses in welds, design of welds, eccentrically loaded welded joints

Tension Members: Types of tension members, net and gross areas, permissible stresses. Design of members subjected to axial loads, combined bending moments and axial loads, lug angles. Tension Splice

Compression Members: Failure modes of columns, end conditions and effective length of columns, various empirical formulae. IS code formula, General codal provisions for design of compression members, Built up compression members, lacing and battening of compression members, splicing of compression members.

Column Bases and Foundations: Types of column bases, design of slab base, Gussetted base and grillage foundations.

Design of Flexural Members: Failure modes permissible stresses, design of laterally supported and unsupported beams, web crippling, web buckling, compound beams.

Design of plate Girders: Components of a plate girder, basic design assumptions, stiffeners in plate girders, design of various components of a welded and riveted plate girder.

Roof Trusses: Types of roof trusses loads on roof trusses, calculation of forces due to combination of different loads, Design of members and joints.

Course outcomes

- Understand the different types of steel joints and their design.
- Knowledge of design provisions given in Indian standard code.
- Able to design the basic elements like, tension and compression members, column bases, plate girder.
- Able to analyze and design the roof trusses.

Text and Reference Books:

1. Chandra R, "Design of Steel Structures" Standard Publishing House, 1999.
2. Raghupathi M, "Design of Steel Structures" Tata McGraw-Hill, New Delhi, 1998.
3. Arya A S and Ajmani J L, "Design of Steel Structures" Nem Chand Bros. Roorkee,2000.
4. Kazimi S M A and Jindal R S, "Design of Steel Structures" Prentice Hall of India, New Delhi,1999.
5. Dayaratnam P, "Design of Steel Structures" Wheeler Publishers, New Delhi, 1999.

CEMI-308 Elements of Earthquake Engineering 3 0 0 3

Course Objectives

- To make the students familiar with the dynamics problems for damped and undamped free vibration for single degree freedom system.
- To make the students understandable regarding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To do seismic design and detailing of structures with reference to is code.

Course Syllabus

Undamped free vibrations of single degree of freedom systems: Introduction, definitions, characteristics of a dynamic problem, degrees of freedom, Newton's law of motion, De Alembert's Principal, free body diagram, derivations of differential equation of motion, solution of differential equation of motion, equivalent stiffness of spring combinations, springs in series, springs in parallel.

Damped free vibrations of single degree of freedom systems: Introduction, types of damping, free vibrations with viscous damping, over-damped, critically- damped and under- damped systems, logarithmic decrement, structural damping.

Earthquake Resistant Design Philosophy: Introduction, criteria for earthquake resistant design, principles of reliable seismic behaviour, structural forms for earthquake resistance, earthquake forces versus other forces.

Lateral Load Analysis: Idealization of structures and selection of analysis, equivalent lateral force concepts, response spectrum analysis, seismic forces as per IS : 1893 – 1984 and IS : 1893 – 2002.

Behaviour and Design of Concrete Structures: Characteristics of concrete and reinforcing steel, influence of bond and anchorage and confinement of concrete, Seismic design and detailing of reinforced concrete and masonry buildings (IS 13920; IS 13827: IS 13828; IS 4326) and flexural strength and ductility of RC members.

Course outcomes

- Study the dynamics problems for damped and undamped free vibration for single degree freedom system.
- Understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- Able to do seismic design and detailing of structures with reference to is code.

Text and Reference Books:

1. Paz M, “Structural Dynamics – Theory and Computation” CBS Publishers and Distributors, New Delhi, 2003.
2. Chopra A K, “Structural Dynamics” John Wiley & Sons, New Delhi, 2002.
3. Dowrick D J, “Earthquake Resistant Design for Engineers and Architects” John Wiley & Sons, New York, 2000.
4. Paulay and Priestley, “Seismic Design of Reinforced Concrete and Masonry Buildings” John Wiley and sons, New York, 1992.
5. Rao S S,”Mechanical Vibrations” Pearson Education Publishers, 2004.

VIIth Semester

CEMI-401 Design of Hydraulic Structures 3 0 0 3

Course Objectives

- To inculcate the essentials of hydraulic structures in Civil Engineering field.
- To provide the students an illustration of the significance of the hydraulic structures in Civil Engineering Profession in satisfying societal needs.
- To demonstrate various methods to design these structures and show its economic

Course Syllabus

Dams: Gravity dams, arch dams and earthen dams, also introduction about rivers and canal projects in Punjab.
Earth Dams: Components of earth dams and their functions, Phreatic line determination by analytical and graphical methods.
Theory of Seepage: Seepage force and exit gradient, salient features of Bligh’s Creep theory, Lane’s weighted Creep theory and Khosla’s theory Determination of uplift. Pressures and floor thickness.
Gravity Dams-Non Overflow Section: Forces acting, Stability factors, stresses on the faces of dam, Design of profile by the method of zoning, Elementary profile of a dam.
Gravity Dams Spillways: Creagers profiles neglecting velocity of approach, profile taking velocity of approach into account, upstream lip and approach ramp, Advantages of gated spillways, Discharge characteristics of spillways.
Arch Dam: Classification of arch dam-constant radius constant angle and variable radius types, cylinder theory, expression relating central angle and cross-sectional area of arch. Types of buttress dams, advantages of buttress dams.
Energy Dissipation Devices: Use of hydraulic jump in energy dissipation, Factors affecting design, types of energy dissipation and their hydraulic design.
Dam’s Safety: instruments, stress-strain meter, piezometric reading of seepage, seepage analysis, sensors.
Canal Falls: Necessity and location, types of falls and their description, selection of type of falls, principles of design, design of Sarda type, straight glacis and inglis or baffle wall falls.
Distributory Regulators: Off take alignment, cross regulators-their functions and design, Distributory head regulators - their functions and design, canal escape.
Cross Drainage Works: Definitions, choice of type, hydraulic design considerations. Aqueducts their types and design, siphon aqueducts their types and design considerations, super passages, canal siphons and level crossings.
Design of Weirs: Weirs versus barrage, design consideration with respect to surface flow, hydraulic jump and seepage flow. Design of a barrage or weir.

Tunnels: Head-race tunnel, diversion tunnel.

Course outcome:

- Analysis and Design of different types of dams like, gravity dams, arch dams, buttress dams, earthen dams.
- Design of canal outlets.
- Design of cross drainage works and diversion head works.
- Study of theory of seepage
- To know about energy dissipation devices and their applications

Text and Reference Books:

1. Sharma S K, “Design of Irrigation Structures” S. Chand & Company (Pvt.) Ltd., New Delhi.
2. Murty C S, “Design of Minor Irrigation and Canal Structures” Wiley Eastern Ltd. New Delhi.
3. Garg S K, “Irrigation Engineering & Hydraulic Structures” Khanna Publishers, Delhi,1999.
4. Arora K R, “Irrigation Waterpower & Water Resources Engineering” Standard Publishers Distributors, Delhi, 2003.
5. Asawa G L, “Irrigation Engineering” Wiley Eastern Ltd., New Delhi 2001.

VIIIth Semester

CEMI-402 Estimating and Costing 3 0 0 3

Course Objectives

- To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering.
- To provide the students knowledge regarding estimation of quantities involved in Civil engg. works

Course Syllabus

Estimates: Types, complete set of estimate, working drawings, site plan, layout plan, index plan, plinth area, administrative approval and Technical Sanction.

(i) Estimate of buildings
(ii) Estimate of R. C.C. works
(iii) Estimate of sloped roof and steel structures
(iv) Estimate of water supply and sanitary works
(v) Estimates of roads (a) Earthwork (b) Bridges and culverts c) Pavement
(vi) Estimate of Irrigation works.

Analysis of Rates: For earthwork, concrete works, D. P. C., Brickwork, stone masonry, plastering, pointing, road work, carriage of materials.

Specifications: General specification for different classes of building, detailed specifications for various Civil Engineering Works.

Contracts: Types of contracts, tender, tender notice, tender form, submission and opening of tender, earnest money, security money, measurement book, muster roll, piecework agreement and work order

Accounts: Division of accounts, cash, receipts of money, cashbook, temporary advance, imprest and accounting procedure.

Arbitration: Arbitration, arbitrator and arbitration act, powers of arbitrator, arbitration awards.

Course Outcomes

- Able to prepare rough and detailed estimate of buildings for different items.
- Knowledge of specifications of different items of building.
- Able to perform rate analysis of different work items.
- Knowledge of contracts, accounts and arbitration.

Text and Reference Books:

1) Chakraborti, M., 2002. Estimating and costing, Calcutta.
2) Dutta, B. N., 1999. Estimating and costing in civil engineering. UBS Publishers' Distributors Ltd., New Delhi.
3) Birdie, G. S., 1994. Estimating and costing, Dhanpat Rai & Sons, Delhi.
4) Kohli, D. and Kohli, R.C., 2004. Estimating and costing. S.Chand & Company, New Delhi.
5) Spence, G., 1950. Building and public works administration: estimating and costing. Newnes Publishers, London, UK.

Teaching scheme and syllabus for M.Tech. (Structural & Construction Engineering)

Enclosure #3

CURRICULUM

M. TECH.
in
STRUCTURAL AND CONSTRUCTION ENGINEERING

(July 2019 admission onwards)

APPROVED BY

BOARD OF STUDIES (BOS)

12th MEETING, February 20, 2019

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

TEACHING SCHEME

Semester – I*

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - I	3	0	0	3
CE	Course - II	3	0	0	3
CE	Course - III	3	0	0	3
CE	Course - IV	3	0	0	3
CE	Course - V	3	0	0	3
CE	Lab-I	0	0	3	2
CE	Lab-II	0	0	3	2

Semester - II

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - VI	3	0	0	3
CE	Course - VII	3	0	0	3
CE	Course - VIII	3	0	0	3
CE	Course - IX	3	0	0	3
CE	Course - X	3	0	0	3
CE	Lab-III	0	0	3	2
CE	Lab-IV	0	0	3	2
Total					19

Semester – III*

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - XI	3	0	0	3
CE	Course - XII	3	0	0	3
CE	Independent Study	0	0	6	3
CE	Dissertation Part I	0	0	12	6*
Total					**15**

Note: 8 Core courses including Independent study and Dissertations and 6 elective courses need to be completed for the degree.

Semester – IV@

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Dissertation Part II	0	0	24	12*
Total		0	0	24	**12**

@*The result of Dissertation Part I & II shall be forwarded cumulatively after evaluation of dissertation*

Grand Total of Credits = 65

LIST OF CORE COURSES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-501	Advanced Solid Mechanics	3	0	0	3
2.	CE-502	Advanced Reinforced Concrete Design	3	0	0	3
3.	CE-503	Structural Dynamics	3	0	0	3
4.	CE-504	Analysis and Design of Foundations	3	0	0	3
5.	CE-505	Finite Elements Analysis	3	0	0	3
6.	CE-506	Earthquake Resistant Design of Structures	3	0	0	3
7.	CE-507	Advanced Structural Analysis	3	0	0	3
8.	CE-508	Advanced Construction Practices	3	0	0	3
9.	CE-509	Quantitative Methods in Construction Management	3	0	0	3
10.	CE-601	Independent Study	0	0	6	3
11.	CE-600	Dissertation Part-I Dissertation Part-II	0	0	30	6+12

LIST OF LABORATORY COURSES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-520	Foundation Engineering Laboratory	0	0	3	2
2.	CE-521	CAD Laboratory	0	0	3	2
3.	CE-522	Concrete Structures Laboratory	0	0	3	2
4.	CE-523	Material Testing Laboratory	0	0	3	2

LIST OF ELECTIVES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-510	Quality and Safety Management in Construction	3	0	0	3
2.	CE-511	Construction Economics and Finance	3	0	0	3
3.	CE-512	Repair and Retrofitting of Structures	3	0	0	3

4.	CE-513	Advanced Numerical Methods	3	0	0	3
5.	CE-514	Highway Construction and Maintenance	3	0	0	3
6.	CE-515	Theory of plates And Shells	3	0	0	3
7.	CE-516	Geospatial Technologies	3	0	0	3
8.	CE-517	Pre-stressed Concrete Design	3	0	0	3
9.	CE-518	Infrastructures Development Projects	3	0	0	3
10.	CE-519	Analysis and Design of Tall Buildings	3	0	0	3
11.	CE-526	Construction Methods and Equipment	3	0	0	3
12.	CE-527	Design of Industrial Structures	3	0	0	3
13.	CE- 528	Advanced Steel Design	3	0	0	3
14.	CE- 529	Soil Dynamics and Machine Foundations	3	0	0	3
15.	CE-530	Construction and Contract Management	3	0	0	3
16.	CE-531	Geoenvironmental Engineering	3	0	0	3
17.	CE-532	Landfill and Ash ponds	3	0	0	3
18.	CE-533	Solid and Hazardous Waste Management	3	0	0	3
19.	CE-534	Concrete Mechanics	3	0	0	3
20.	CE-535	Recent Advances in Construction Materials	3	0	0	3
21.	CE-536	Composite Materials	3	0	0	3
22.	CE-537	Simulation & Modelling	3	0	0	3
23.	CE-538	Site Investigations and Ground Improvement	3	0	0	3
24.	CE-539	Engineering Behaviour of Soils	3	0	0	3
25.	CE-540	Geosynthetics	3	0	0	3
26.	CE-541	Pavement Analysis, Design and Construction	3	0	0	3
26.	ID-601	Research Methodology	3	0	0	3
27.	CE-590	Modelling and Research methodology	3	0	0	3

CE 501 Advanced Solid Mechanics [3-0-0-3]

Course Objectives

- To understand solving Methods of three-dimensional stress and strain analysis and extended to allow the student and to obtain solutions using analytical as well as numerical methods.
- This subject will include the analyses of principal stresses and strains, state of stress and strain, true stress-true strain and generalized Hooke's law and failure criteria.
- In addition, this subject will focus on plastic deformation of solids, including the analysis of residual stresses and the collapse load of structures subjected temperature and mechanical loading.
- To understand the responses of materials to fatigue and fracture, as well as their creep and viscoelastic behavior.

Course Syllabus

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

Course Outcomes

- This subject helps to understand the theory of elasticity including strain/displacement and Hooke's law relationships;
- As outcome, subject helps to analyze solid mechanics problems using classical methods and energy methods;
- To solve for stresses and deflections of beams under unsymmetrical loading;
- To locate the shear center of thin wall beams; and to obtain stresses and deflections of beams on elastic foundations;

- To obtain solutions to column buckling and plate problems; as well as to apply various failure criteria for general stress states at points.

Text and Reference Books:

1. Timoshenko S P and Goodier J N “Theory of Elasticity” McGraw Hill, New York,2002.
2. Housner G W and Vreeland J R “The Analysis of Stress and Deformation” Mcmillan London, 1998.
3. Srinath L S “Advanced Mechanics of Solids” Tata Mcgraw Hill, New Delhi, 2000.
4. Westergaard H M “Theory of Elasticity and Plasticity” Harvard University Press, Cambridge, 1998.
5. Kazimi S M A “Solid Mechanics” Tata McGraw Hill, New Delhi, 1999.

CE-502 Advanced Reinforced Concrete Design [3 0 0 3]

Course Objective:

- To make students Understandable about the various elements of different types of industrial and non-industrial RCC structures.
- To make students’ Knowledgeable of design provisions given in Indian standard code.
- To make students able to design the basic elements like, beams, slab.
- To make students able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

Course Syllabus:

Deflections of Reinforced Concrete Beams and Slabs; Estimation of Crack Widths in Reinforced Concrete Beams; Inelastic Analysis of Reinforced Concrete Beams and Frames; Design of Shear Walls, Cast-in-Situ Beam-Column Joints, Deep Beams, Chimneys, Ribbed Slabs; Design of Reinforced Concrete Members for Fire Resistance; Software Applications, Virendeel Girders, Concrete Trusses.

Course Outcome:

- Understand the various elements of different types of industrial and non-industrial RCC structures.
- Knowledge of design provisions given in Indian standard code.

- Able to design the basic elements like, beams, slab.
- Able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

Books Recommended:

1. Varghese P C "Advanced Reinforced Concrete Design" Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.

2. Krishna Raju N "Advanced Reinforced Concrete Design" CBS Publishers and Distributors, New Delhi, 1988.

3. Park R and Paulay T "Reinforced Concrete Structures" John Wiley and Sons, New York, 1975.

4. SP 208 "Examples for the Design of Structural Concrete with Strut – and – Tie Models" Editor: Karl – Heinz Reineck, American Concrete Institute, Michigan, 2003.

5. Leet, Kenneth M and Bernal D "Reinforced Concrete Design" McGraw Hill, London, 1998.

CE 503 Structural Dynamics [3-0-0-3]

Course Objective:

- To analyze structures subjected to any kind of dynamic excitation and computing quantities like displacements, forces, stresses, etc.
- Understanding the analytical methods and procedures in a way that emphasize physical insight.
- Ability to apply the structural dynamics theory to real-world problems like seismic analysis and design of structures.
- To study the mode shapes and frequencies of single and multi degree of freedom of structures.

Course Syllabus

Concept of degrees of freedom and constraints, Equations of motion, Newton's Law and De Alembert's Principle, Response of single degree of freedom systems to initial conditions, Response to harmonic excitation, Dynamic amplification factor, Transmissibility, Base Isolation, Response to non harmonic excitations such as impulse, step loading and blast loading, Duhamel's Integral, Earthquake response analysis, Response spectrum, Theory of vibration pick – ups, Estimation of dynamic characteristics through experimental investigations, Multi degree of freedom systems, Orthogonality of mode shapes, Mode superposition method for seismic analysis.

Course Outcome:

- Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
- Create simple computer models for engineering structures using knowledge of structural dynamics interpret dynamic analysis results for design, analysis and research purposes apply structural dynamics theory to earthquake analysis, response, and design of structures

Books Recommended:

1. Clough R W, Penzien J, "Dynamics of Structures", McGraw-Hill, Inc, New York, 1991.
2. Chopra A K "Dynamics of Structures: Theory and Applications to Earthquake Engineering" Prentice Hall (India) Private Ltd, New Delhi, 2000.
3. Roy Creig Jr. "Structural Dynamics: An Introduction to Computer Methods", John Wiley & Sons, New York, 1981.
4. James M L, Smith G M, Wolford J C and Whaley P W "Vibration of Mechanical and Structural Systems : With Microcomputer Applications", Happer & Row, Publishers, New York, 1989.
5. Rao S S, "Mechanical Vibrations", Pearson Education, New Delhi, 2004.

CE-504 Analysis and Design of Foundation Structures [3 0 0 3]

Course Objective:

- To be able to develop deeper understanding of shallow and deep foundations.
- To be able to develop understanding of different design parameters.
- To be able to design foundations and reinforced retaining walls.

Course Syllabus:

Introduction to shallow and deep footings, Design of strap, Raft and combined footings, Design of pile footings, Caps for piles, design of different components of well foundations, Footings subjected to eccentric loading, uplift and overturning, Soil-Structure interaction, Sub grade reaction method, Geotechnical design considerations, Site and soil conditions, Soil liquefaction, Evaluating the liquefaction potential by Standard Penetration Tests, by Cone Penetration Tests, by

Shear Wave Velocity, Liquefaction of clayey soil, Mitigation of Liquefaction Hazard by site modification, Mitigation of Liquefaction Hazard by Structural Design, Seismic Settlement, Subsidence and Differential Compaction, Fault Rupture, Lateral Seismic Earth Pressures.

Course Outcome:

- Students will be able to design shallow and deep foundations.
- Students will be able to determine different design parameters.
- Students will be able to design reinforced retaining wall.

Books Recommended:

1. Saran S "Analysis and Design of Sub-Structures" Oxford and IBH, New Delhi, 1996.
2. Bowls J E "Foundation Analysis and Design" Mc Graw Hill, New York, 1988.
3. Peck R B, Henson W E and Thorn burn W T "Foundation Engineering" John Willey and Sons, New York, 1984.
4. Teng W C "Foundation Design" Prentice Hall, New Delhi, 1992.
5. Naeim F "The Seismic Design Hand Book", Kluwer Academic Publishers, London, 2001.
6. Krammer S "Geotechnical Earthquake Engineering" Pearson Education Pvt. Ltd. New Delhi, 2003.

CE 505 Finite Elements Analysis [3-0-0-3]

Course Objective:

- To implement the basics of FEM to relate stresses and strains.
- To solve one, two and three dimensional and dynamic problems using Finite Element Analysis.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements;
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Syllabus

Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, Some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

Course Outcome:

- Implement numerical methods to solve mechanics of solids problems.
- Formulate and Solve axially loaded bar Problems.
- Formulate and analyze truss and beam problems.
- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
- Formulate and solve Axi-symmetric and heat transfer problems.

Books Recommended:

1. Zienkiewiez O. C., "The Finite Element Method" Mcgraw Hill, London, 1991.
2. Abel J F and Desai C A "Finite Element Method" Van Nostrand Reinhold, New York., 2004.
3. Reddy, J.N., "An Introduction to the Finite Element Method", Tata McGraw Hill, New Delhi, 2003.
4. Bathe K J "Finite Element Procedures" prentice Hall of India Private Limited, New Delhi, 1997.
5. Chandrupatla T R and belegundu A D "Introduction to Finite Elements in Engineering" Prentice Hall of India Private Limited, New Delhi, 1997.

CE-506 Earthquake Resistant Design of Structures [3 0 0 3]

Course Objective:

- To Study the multimodal and multidirectional response spectrum analysis.
- To make students familiar regarding understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To make students able to do seismic design and detailing of structures with reference to is code.

Course Syllabus:

Behaviour of buildings and structures during past earthquakes and lessons learnt, goals of earthquake resistant design. Linear static procedure for seismic load calculation – IS 1893 – 2002, 2016 combination of gravity and seismic action. Multimodal and Multidirectional response spectrum analysis. Earthquake resistant measures at planning stage: Geotechnical and architectural considerations, irregularities, earthquake resistant measures in sloping roofs, staircase, foundations and general construction details IS : 4326 –1993, principals of earthquake resistant design – behaviour of concrete and steel, confined concrete, the capacity design method; Study of IS 13920 – 1993, 2016 behaviour of masonry structures during earthquakes, analysis and behaviour of masonry infilled RC frames, earthquake resistant measures in masonry buildings.

Course Outcome:

- Study the multimodal and multidirectional response spectrum analysis.
- Understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- Able to do seismic design and detailing of structures with reference to is code.

Books Recommended:

1. Dowrick D J "Earthquake Resistant Design for Engineers and Architects" John Wiley and Sons, New York, 1987.
2. Dowrick D J "Earthquake Risk Reduction" John Wiley and Sons, New York, 2003.
3. Englekirk R E "Seismic Design of Reinforced and Pre-cast Concrete Buildings" John Wiley and Sons, New York, 2003.

4. Pauley T and Priestley M J N “Seismic Design of Reinforced Concrete and Masonry Buildings” John Wiley and Sons, New York, 1992.
5. Key D “Earthquake Design Practices for Buildings” Telford Publishers, London, 1990.

CE-507 Advanced Structural Analysis [3-0-0-3]

Course Objective:

- To make students able to determine the various properties of cement experimentally
- To determine the specific gravity and water absorption of fine and coarse aggregates.
- To perform various test of fresh and harden concrete.
- To make students able to carry out the test procedure of compressive test and flexure test.

Course Syllabus:

Basic concepts, Degree of static and kinematic indeterminacy, Matrix algebra, Solution of simultaneous equations by Gaussian Elimination, Flexibility and Stiffness Matrices, System Approach: Development of stiffness matrix, Applications of stiffness method to continuous beams, trusses and frames. Effect of temperature, and prestrain. Element Approach: Element stiffness, 2D truss element and beam element, Transformation matrix, Assembly of global stiffness matrix, Storage requirement of stiffness matrix i.e. full storage, banded storage and skyline storage, Effect of node and element numbering, Boundary conditions, Application of stiffness method to beams, trusses and frames. Computer applications, Material and geometrical non-linearity, Application of Virtual work and energy principles.

Course Outcome:

- Determination of various properties of cement experimentally.
- Determination of specific gravity and water absorption of fine and coarse aggregates.
- Various test of fresh and harden concrete.
- Carry out the test procedure of compressive test and flexure test.

Books Recommended:

1. Pandit G S and Gupta S P "Matrix Analysis of Structures" Tata McGraw Hill, New Delhi, 2003.
2. Gere W and Weaver J M "Matrix Analysis of Structures" CBS Publishers, New Delhi, 2002.
3. Rajasekaran S and Sankarasubramanian G "Computational Structural Mechanics" Prentice Hall India, New Delhi, 2001.
4. Vazirani V N and Ratwani M M "Advanced Theory OF structures and Matrix Method" Khanna Publishers, New Delhi, 1995.

CE-508 Advanced Construction Practices [3 0 0 3]

Course Objective:

- To give an experience in the implementation of new technology concepts which are applied in field of advanced construction.
- To enable students to describe, analyze, compare and evaluate the technology of mass concreting, industrialised construction and special construction methods.
- To aware the students of some of the problems that can be associated with construction in extreme weathers and difficult conditions.

Course Syllabus:

Concrete Construction Methods, Formwork Design and Scaffolding; Slip Forms and other moving forms; Pumping of Concrete; Grouting and Mass Concreting Operations (roller compacted concrete); Ready-Mix Concrete; Various Methods of Handling and Placing Concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Prestressing. Steel and Composite Construction Methods**,** Fabrication and erection of structures including heavy structures, Prefab construction, Industrialised construction and Modular coordination. Special Construction Methods, Construction in Marine Environments, High Rise Construction, Bridge Construction including Segmental Construction, Incremental Construction and Push Launching Techniques; Geosynthetics; Safety, Quality Measures and Reliability.

Course Outcome:

- Students shall understand the latest construction techniques applied to Engineering Construction.

- Students will attain an overall picture of special construction methods with a good understanding of the onsite construction issues and gain an insight in constructing civil, industrial, bridges and building type projects in extreme conditions.

Books Recommended:

1. Neville A M and Brooks J J "Concrete Technology",Pearson Education Asia, Singapore, 1994.
2. Neville A M "Properties of Concrete", Pearson Education, New Delhi, 2004.
3. Peurifoy R L "Construction Planning, Equipment and Methods" McGraw Hill Ltd., New York, 2002.

CE-509 Quantitative Methods in Construction Management [3 0 0 3]

Course Objective:

- Review the basic concepts of probability and statistics.
- To apply linear programming for optimization of various problems.
- To get familiar with queuing theory, decision theory and game theory.
- To get overview of modifications and improvement on CPM/PERT techniques.

Course Syllabus:

Introduction and concepts of probability and statistics, Optimization through Linear programming- Need for linear programming, Linear programming model, dual problem, dynamic programming. Transportation model, solution of Transportation model, Assignment problems, solution of assignment problem. Queuing theory- waiting line models, deterministic model, probabilistic model, Decision theory- decision analysis, decision under uncertainity, Nature of Games, Games model, solution of Games model, simulations as applied to construction-simulation models, steps in simulation, Monte carlo simulation. Modifications and improvement on CPM/PERT techniques.

Course Outcome:

- Students will learn the basics of probability and statistics, linear programming for optimization, queuing theory, game theory and CPM/PERT tecniques.

Books Recommended:

1. Verma M “Construction Planning and Management Through System Techniques” Metropolitan Book Company, New Delhi, 1985.
2. Chitkara K K “Construction Project Management – Planning, Scheduling and Controlling” Tata McGraw Hill, New Delhi, 2000.
3. O’Brien J “CPM in Construction Management” McGraw Hill, New York, 1999.
4. Harris R B “Precedence and Arrow Networking Techniques for Construction” John Wiley & sons, New York, 1999.
5. Levy S “Project Management in Construction” McGraw hill, New York, 2000.

CE-520 Foundation Engineering Laboratory [0 0 3 2]

Course Objective:

- The objective is to learn to perform tests on soil and determine the properties of various soils

Course Syllabus:

Plate load test,
Standard penetration test,
Static cone penetration test,
Dynamic cone penetration test
Triaxial shear test,
Large shear box test and
testing of Geotextiles and geofibres.

Course Outcome:

- Students will be able to perform different tests on soils

CE 521 CAD Laboratory [0-0-3-2]

Course Objective:

- To impart fundamental knowledge to students in the latest technological topics on Computer Aided Design, analysis of building and Computer Aided Engineering Analysis.

- To create congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.
- To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

Course Syllabus:

Introduction to various research and design softwares and their applications

- Comparison of Numerical and theoretical deflection of single and multispan beam with pinned and fixed supports
- Analysis and design of G+4 building against Dead and Live load using STAAD Pro.
- Analysis and design of Multistorey framed building against Earthquake & wind loading using STAAD Pro.
- Analysis and design of steel truss against seismic loading using STAAD Pro.
- Analysis and design of suspension Cable Bridge using STAAD Pro.
- Determine the stress and deformation of one way and two way slab using ABAQUS/CAE.
- Determine the stress and deformation of singly and doubly reinforced concrete beam using ABAQUS/CAE.
- Determine the stress and deformation of axially loaded reinforced concrete column using ABAQUS/CAE.
- Determine the stress and deformation of steel truss bridges using ABAQUS/CAE.

Course Outcome:

- Apply solutions or to do research in the areas of Design and simulation in the field of civil Engineering.
- Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.
- Formulate relevant research problems; conduct analytical study and analyzing results with modern mathematical methods and use of software tools.
- Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.

CE-522 Concrete Structures Laboratory [0-0-3-2]

Course Objective:

- To perform the testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

Course Syllabus:

- Testing of PCC and SFRC samples under compression and flexural testing under static and
- fatigue loading.

Course Outcome:

- Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

CE-523 Material Testing Laboratory [0 0 3 2]

Course Objective:

- To make students aware about the design of concrete mixes for high strength and high performance of fly ash concrete.

Course Syllabus:

- Design of concrete mixes for high strength and high performance of flyash concrete.

Course Outcome:

- Design of concrete mixes for high strength and high performance of fly ash concrete.

CE 601 Independent Study [0-0-6-3]

Course Objective:

- To develop students into self-directed learners and independent researchers.
- To provide more scope and depth in the Graduate Kinesiology curriculum by encouraging students to Investigate areas of interest not currently included in any approved course at NIT Jalandhar.
- To study areas and develop projects that cut across existing course boundaries.
- To understand more deeply into specific parts of an existing course offering.

- To provide the student with sufficient circumstances to assess personal aptitude for the sport management, fitness management, or sports studies field.
- To develop a critical understanding of and the ability to apply theoretical knowledge from the student's chosen concentration, sport management, fitness management, or sports studies, in a research or self-directed learning environment.

Guidelines:

This is a seminar oriented subject in which the student is required to select a topic of his interest related to recent developments and the state-of-the art in the field under study in consultation with a designated faculty advisor. The student shall be required to carry out a comprehensive literature survey on the selected topic and compile a detailed report and present a minimum of two seminars comprising of one mid-term seminar and one end semester seminar. A continuous evaluation of the student performance in terms of seminar presentation and final report shall be carried out.

Course Outcome:

- Students will be required to identify, describe, and document at least three personal learning outcomes specific to their independent study to help ensure their independent study experience is congruent with their personal, professional goals.
- These outcomes must be included on the student's independent study report and approved by their faculty advisor.

CE 600 Dissertation Part-I [0-0-6-6] and
Dissertation Part-II [0-0-24-12]

Guidelines:

Candidate should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for Dissertation and finalize/ settle it in consultation with Guide/ Supervisor.

Pursuant to this, the candidate shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.

Candidate should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The learner shall compile the report in standard format.

Candidates are advised to publish in reputed International/National Conference and reputed International/National journal.

The work to be pursued as a part of the dissertation shall be divided broadly in two parts, namely Dissertation I and Dissertation II.

The topic of the Dissertation should be such that it is a value addition for the existing knowledge in the field and has some worthwhile research input.

CE-510 Quality and Safety Management in Construction [3 0 0 3]

Course Objective:

- To introduce the students about quality and safety related challenges in construction industry.
- To make students aware about the globally recognized guidelines/theories for quality and safety in construction.
- To understand the importance of safety management in construction and the reduction of accidents on construction sites.

Course Syllabus:

Introduction to quality: Planning and control of quality during design of structures. Quantitative techniques in quality control. Quality assurance during construction. Inspection of materials and machinery. In process inspection and test. Preparation of quality manuals, check-list and inspection report. Establishing quality assurance system. Quality standards/codes in design and construction. Concept and philosophy of total quality management (TQM). Training in quality and quality management systems (ISO-9000). Concept of safety. Factors affecting safety; physiological, Psychological and Technological. Planning for safety provisions. Structural safety. Safety consideration during construction, demolition and during use of equipment. Management of accidents/injuries and provision of first aid. Provisional aspect of safety. Site management with regard to safety recommendations. Training for safety awareness and implementation. Formulation of safety manuals. Safety legislation, standards/codes with regard to construction. Quality vs Safety. Case Studies.

Course Outcome:

- Students will understand the concept of QC (quality control), quality assurance (QA) and TQM (Total Quality Management) in construction projects.
- Students will be able to recognize and evaluate occupational safety and health hazards onsite, and to determine appropriate hazard controls following the hierarchy of controls. Students will furthermore be able to analyze the effects of onsite exposures, injuries and illnesses, fatalities and the methods to prevent incidents at construction site.

Books Recommended:

1. Fox A J and Cornell H A "Quality in the Construction Projects" American Society of Civil Engineers, New York, 1992.

2. Hellard R B "Total Quality in Construction Projects: Achieving Profitability with Customer Satisfaction" Thomas Telford, London, 1993.

3. Davies V J and Thomasin K "Construction Safety Handbook" Thomas Telford, London, 1997.

4. Thorpe B "Quality Assurance in Construction" Gower, Aldershort, 1996.

5. NICMAR "Safety Management in Construction Industry – A Manual for Project Managers" NICMAR, Mumbai, 1998.

6. NICMAR "Handbooks of Safety in Construction" Vol. 1 to 6. NICMAR, Mumbai, 1998.

CE-511 Construction Economics and Finance [3-0-0-3]

Course Objective:

- To evaluate construction project economics, cost-benefit analysis, breakeven analysis and to analyze construction risks and uncertainties.
- Understand the importance of working capital management, budgeting and control.
- To study the need for financial management and means of achieving the same.
- Provide students with an economic perspective of the real estate and construction sectors, and an understanding of their roles on the general economy.

Course Syllabus:

Construction accounting, Income statement, Depreciation and amortization, Engineering economics, Time value of money, discounted cash flow, NPV, ROR, Pl, Bases of comparison, Incremental rate of return, Benefit-cost analysis, Replacement analysis, Break even analysis, Risks and uncertainties and management decision in capital budgeting. Taxation and inflation. Work pricing, cost elements of contract, bidding and award, revision due to unforeseen causes, escalation. Turnkey activities, Project appraisal and project yield. Working capital management, financial plan and multiple source of finance. International finance, Budgeting and budgetary control, Performance budgeting, appraisal through financial statements, Practical problems and case studies.

Course Outcome:

- On completion of this course the students will be able to know Life cycle costing, Financial Planning and Management for the construction project and Economical analysis of construction projects.
- Students will be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
- Students will understand the economic principles that underpin construction activities and will be able to use and apply cost planning and control techniques.

Books Recommended:

1. Palmer W J "Construction Accounting and Finance" McGraw hill, New Delhi, 1994.
2. Kuehal S C "Corporate Finance" Tata McGraw Hill, New Delhi, 1995.
3. Block S B and Geoffery A H "Foundations of Financial Management" McGraw Hill, London, 2001.
4. Singh H "Construction Management and Accounts" Tata McGraw Hill, New Delhi, 1993.

CE-512 Repair and Retrofitting of Structures [3-0-0-3]

Course Objective:

- To make students familiar about the understanding of the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- To make students Knowledgeable of different types of rocks and minerals and their physical properties.
- To make students Knowledgeable of in situ determination of engineering properties of rock masses.

- To make students understandable regarding the concepts of folds and faults, their classification and relation to engineering purposes.

Course Syllabus:

Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

Course Outcome:

- Understand the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- Knowledge of different types of rocks and minerals and their physical properties.
- Knowledge of in situ determination of engineering properties of rock masses.
- Understand the concepts of folds and faults, their classification and relation to engineering purposes.

Books Recommended:

1. Bungey J H “Testing of Concrete in Structures” Surrey University Press London, 1989.

2. Paulay T & Preistley “Seismic Design of Reinforced Concrete Structures and Masonry Buildings” John Wiley and Sons London, 1992.

3. ATC-40 (Vol. 1 & 2) “Seismic Evaluation and Retrofitting of Concrete Buildings” Applied Technology Council California, 1996.

4. FEMA – 273 “NEHRP Guidelines for Seismic Rehabilitation of Buildings” Building Seismic Safety Council Washington, 1997.

5. FEMA – 310 “Handbook for Seismic Evaluation of Buildings – a pre standard” Building Seismic Safety Council Washington, 1998.

6. Krammer S "Geotechnical Earthquake Engineering" Pearson Education pvt. Ltd. New Delhi, 2003.

CE 513 Advanced Numerical Methods [3-0-0-3]

Course Objectives:

- To understand the different numerical methods and presently available methods
- To be able to use different numerical methods for solving various geotechnical problems

Course Syllabus:

Introduction Solutions to linear equations, properties of matrices, Eigen values and Eigen vectors, solutions of linear systems; direct methods and iterative methods, Computation of Eigen values, solutions to the problems using programming languages (C, C++, FORTRAN, MATLAB).

Solutions of non linear equations, importance of non linear equations, different numerical techniques to solve non linear equations (Newton Raphson method, secant method, Aitken method).

Approximation of functions. Introduction, Taylor series, least squares, legendre polynomials, regression analysis.

Numerical differentiation and integration, ODE and PDE, truncation errors.

Course Outcomes:

- Student should be able to use different numerical methods for solving various geotechnical problems.

Text and Reference Books:

1. Chapra, S. C. and Canale R. P., 2003. Numerical Methods for Engineers. Tata McGraw Hill.
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., 1969. Applied Numerical Methods", John Wiley.
3. Heath, M. T., 1997. Scientific Computing : An Introductory Survey. McGraw Hill.
4. Rajasekaran, S., 1999. Numerical Methods in Science and Engineering. S. Chand.

CE 514 Highway Construction and Maintenance [3-0-0-3]

Course Objectives:

- To understand the requirement of materials and their role in pavements
- To gain knowledge of various types of failures in pavements and their specific remedy

Syllabus:

Materials for road construction: material properties (physical and chemical) of bitumen, cutback, emulsions, stabilizers, polymeric bitumen, elastomeric and plastomeric compounds, aggregates, coarse sand, stone dust, slags, river bed material, soil

Construction of low volume roads: Construction of Earth road, Construction of Gravel road, Construction of WBM roads

Flexible Pavement Construction: various layers: their advantages and requirements, standard materials' requirements, possible types of materials in different layers.

Construction of rigid pavements: various layers: their advantages and requirements, standard materials' requirements, possible types of materials in different layers.

Pavement maintenance and retrofitting: Pavement Failures, Pavement maintenance methods, Evaluation of pavement, Strengthening of existing pavements by overlaying, retrofitting of rigid pavements.

Course Outcome:

- The students will be able to evaluate the condition of pavement and specify requisite measure in terms of either pavement strengthening or maintenance.
- The course will enable students to make use of different materials in the specific layer of pavements.

Recommended Books:

1. Khanna, S. K and Justo, C.E.G. 1991. Highway engineering, Khanna Publishers.
2. Sharma and Sharma, 1980. Principles and practice of highway engg., Asia Publishing House.
3. Teng, 1980. Functional designing of pavements, Mc Graw - Hill.

CE-515 Theory of plates and Shells [3-0-0-3]

Course Objectives:

- To achieve fundamental understanding of the classical theory of plates and shells, address importance of plate and shell structures, introduce analytical solutions and numerical techniques and present detailed design of plate as well as shell structures.

Syllabus:

Plates: Introduction, Classification of pates, Governing equation of thin rectangular plate, Navier's Method of solution for Rectangular Plates subjected to point load, uniformly distributed load, patch load and linear hydro-static load, Levy's Solution, Bending of Orthotropic plates and Governing equation of thin rectangular plate, Analysis and Design of Grid flat thin slab system, Governing equation of Circular plate, Triangular plate and Elliptical plate, Structural behaviour of Folded plate roofs, Slab-beam analysis of folded plates, The vibration of plates.

Shells: Introduction, Type of shells, Equation of equilibrium of Spherical Shells, Design of Spherical shells with/without circular ring beam, Equation of Equilibrium of Conical Shells, Umbrella Shells, Conical water tank, Design of conical roof including edge beam, Equation of Equilibrium of cylindrical shells, Semi-circular shells, Circular cylindrical shells under axisymmetric loading, Analysis of doubly curved shells, Hipped roof.

Course Outcome:

- To enable students to apply the theory of plates and shells to problems, involving various geometries, loading and boundary conditions, to diverse problems in civil engineering and other related fields such as aerospace and mechanical engineering.

Recommended Books:

1. S. P. Timoshenko, and S. W. Krieger "Theory of Plates and Shells," McGraw-Hill, 1959.
2. B.K. Chatterjee, Theory and Design of Concrete Shells" Spon Press; Revised edition, 1988.
3. E.H. Mansfield "The Bending and Stretching of Plates," 2nd edition, Cambridge University Press, 1989.
4. H. Kruas, Thin Elastic Shells, John Wiley & Sons Ltd, 1968.
5. G.S. Ramaswamy, Design and Construction of Shell Structures, CBS Publishers, New Delhi, 1996.

6. E. Ventsel, and T. Krauthammer, Thin Plates and Shells: Theory, Analysis, and Applications, 1st Edition, CRC Press, 2001
7. K. Chandrasekhara, Analysis of Thin Concrete Shells, Oxford and IBH, Kolkata, 1971.
8. J.N. Bandopadhyay Thin Shell Structures, New Age International Publishers, New Delhi, 1986.
9. IS 2210-1988, Criteria for design of reinforced concrete shell structures and folded plates, Bureau of Indian Standards, New Delhi.

CE 516 Geospatial Technologies [3-0-0-3]

Course Objectives:

The goals of this course are to:

- Provide knowledge about the fundamentals of remote sensing, sensor systems and image characteristics
- Provide knowledge about the GPS system and its components, the GPS signal structure, the types of GPS measurements and their errors and biases.
- Provide an introduction to LIDAR data and discusses how to integrate and manage LIDAR data in GIS
- Enhance student understanding of characteristics of spatial data that come from different sources
- Enhance student understanding of data quality issues when integrating different data sources in GIS.

Course Syllabus:

Chapter–1: Geospatial Overview: Introduction to Geospatial Technology, Why to study, Geospatial Technology, Importance of Geospatial Technology.

Chapter–2: Mapping & Cartography: What is Map & its Importance, Map Scale and Types, Elements of Map and Indexing, Map Coordinate System, Interpretation of Satellite Images.

Chapter–3: Remote Sensing: Introduction, Spectral Reflectance Signature, Digital Image Processing, Visual Interpretation of Satellite data, Aerial Photo and Its Interpretation, Advanced Remote Sensing Technologies, Advantages and Benefits of RS, Overview on Remote Sensing Technology, Fundamentals of Remote Sensing, Physics of Electro Magnetic Energy, Remote

Sensing Platforms, Sensors and Data Products, Remote Sensing Applications, Indian Remote Sensing Systems.

Chapter–4: Geographic Information System (GPS): Introduction, Digital Cartography, Advantages and Benefits of GIS, GPS Accuracy and Accuracy factors, Types of GPS, List of Global Navigation System, GPS Today & Limitations of GPS, Uses of GPS Technology. GIS Data Element and Data Structure, Fundamentals of Database Concept, Data Input to GIS System, GIS Data Editing, Attribute Data Linking, Spatial and Non Spatial data Analysis, Map Projection and Coordinate System, Applications of GPS.

Chapter–5: Geographical Information System (GIS), Fundamentals of GIS, Components of GIS. GIS Acquisition of GIS, Data Types of GIS, Application of GIS.

Chapter-6: Trends in Geospatial Technology: Introduction, Remote Sensing Trends & Technology, GIS Trends & Technology, Web Based GIS, Enterprise GIS, Mobile GIS, 3-D Visualization and Fly through, Open GIS, GPS Trends & Technology.

Chapter–7: Applications of Geospatial Technology: Water shed Studies, Flood Studies, Ground water Studies, Health Issues, Utility Studies, Security and Defense Studies, Urban and infrastructure Studies

Course Outcomes:

Upon successful completion of the class, students should be able to:

- Critically evaluate and analyze data quality for their GIS project
- Design a geo-database and defend the data type selection
- Appraise the degree to which remote sensing data can be used efficiently and effectively
- Interpret the GPS signal and the factors that affect signal quality
- Interpret the significance of Dilution of Precision and its effect on position accuracies and evaluate correction techniques
- Decide and defend the use of raster versus terrain when performing analysis with LIDAR data
- Combine LIDAR data with multiple data sources to create more complex three-dimensional surfaces

Recommended Books:

1. Ahmed, El-Rabbany 2012. Introduction to GPS: the global positioning system, Second Edition; published by Artech House.
2. David, L., Verbyla 1995. Satellite remote sensing of natural resources, CRC Press.

CE-517 Prestressed Concrete Design [3-0-0-3]

Course Objective:

- To understand the general mechanical behavior of prestressed concrete.
- To analyze and design prestressed concrete flexural members.
- To analyze and design for vertical and horizontal shear in prestressed concrete.
- To analyze transfer and development length as well as prestress losses.
- To analyze and design for deflection and crack control of prestressed concrete member.

Course Syllabus:

Definition, Basic Principles, Types of prestressing, Systems of prestressing, Loss of prestress, materials used, Advantages and disadvantages. Critical load condition, Permissible stresses, Various suggested methods of design, Dimensionless Design variables, Solution of equations, Design Procedure based on flexure, Minimum weight design, Cable layout and profile of tendons, Design by load balancing method, Code provisions. Allowable stress considerations, Non-dimensionalised allowable stress equations and their solution, Shrinkage Stresses. Two span continuous beams and their analysis, Application of moment distribution method, Design of continuous beams, Continuous beams with variable section. One way and two way slabs, Beam and slab construction, Principal Stresses, failure due to shear, combined bending and shear, Bond, Prestressing cable at the centroidal axis, Symmetric multiple cable, cable with eccentricity, Inclined cables, Spalling and bursting stresses. Compression members, Tension members, Prestressed Concrete Pavements, Folded plates and Shells, Arches, Dams, Rigid frames, Cylindrical tanks.

Books Recommended:

1. Raju N K "Prestressed Concrete" Tata McGraw Hill, New Delhi, 2001.
2. Rajagopalan N "Prestressed Concrete" Narosa, New Delhi, 2002.
3. Dayaratnam P "Prestressed Concrete" Oxford & IBH, New Delhi, 2001.
4. Lin T Y "Prestressed Concrete" John Wiley and Sons, New York, 2002.

5. Nawy E G "Prestressed Concrete : A Fundamental Approach" Prentice Hall, New Delhi, 1995.
6. I.S. : 1343 – 1980 CODE, BIS New Delhi.

Course Outcome:

- Students will be able to identify and apply the applicable industry design codes relevant to the design of prestressed concrete members.
- Student will be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.
- Students will become familiar with the prestressed concrete fabrication and construction process.
- Students will be able to perform an industry relevant design project in a team setting.

CE-518 Infrastructure Development Projects [3-0-0-3]

Course Objective:

- To understand various concepts of infrastructure planning and management and know stages of an Infrastructure Project Lifecycle.
- To understand the role of Private sector and World Bank in infrastructure growth.
- To familiarize with the latest trends in Construction management, Construction materials and Construction machinery required for various types of infrastructure development project.

Course Syllabus:

Introduction: Meaning and Scope. Impact on economic development, standard of living and environment. Reasons for rise of public sector and government in infrastructural activities. Changed socio-economic scenario and current problems and related issues. Emerging trends in project contracting, from labour contracting to EPF turnkey jobs. Policies on infrastructure Development: A historical review of the Government policies on infrastructure. Current public policies on transportations, power and telecom sectors. Plans for infrastructure development. Reforming infrastructure: Reasons for and need of reforms: operations, maintenance and financial, technological and methodological considerations, Role of World Bank and other multilateral funding agencies in reform movement. Private Sector Participation: Options in infrastructure development and management. Commercial principles options and mechanisms of involvement. Joint Sector, corporatiozation, privatization and other means of financing. Experience of other countries.

Mechanisms: BOT, BOOT, BOO and other mechanisms. Experience of other countries and in India thus far. General guidelines on making Joint Ventures and private sector participation. Construction and Infrastructure: Construction component of various infrastructure sectors. Highway, ports and aviation, power, telecom, railways, irrigation. Current scenario, future needs, investment needed, regulatory framework, government policies and future plans. Technological and methodological demands and innovations on in constructors, construction Management: construction Management in infrastructure development projects. Training of construction managers. New trends in management and construction projects. Construction materials and machinery required for various types of infrastructure development projects. Innovations in technologies, methodologies and management in construction of infrastructure projects. International designs and specifications and techniques of project execution.

Books Recommended:

1. Vaid K "Construction and Infrastructure Development – Issues and Challenges" NICMAR, 2003.

2. India Infrasturcture Report 2001 & 2002, Oxford University Press, New Delhi, 2001/02

3. NICMAR, Construction Business Opportunities in Infrastructure Development in India, NICMAR, Mumbai, 2001.

4. Parikh K S "India Development Report 1999-2000" Oxford University Press, New Delhi, 1999.

5. Rakesh Mohan Committee "The India Infrastructure Report" National Council of Applied Economic Research, New Delhi, 1996.

Course Outcome:

After the completion of course, students will be able to:

- Gather background information and research and describe its impact on the infrastructure project.
- Understand the concepts of financial, economic, social and environmental impact and describe and explain how these are undertaken in an infrastructure project.

- Students will be able to understand the challenges and strategies for successful Infrastructure Project Implementation.

CE-519 Analysis and Design of Tall Buildings [3-0-0-3]

Course Objective:

- To make students aware about the structural elements and types of structural elements for tall buildings.
- To make analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- To make students knowledgeable of design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Course Syllabus:

Principles of Planning, Technological Planning, Mechanical systems, Fire rating, local consideration, structures elements, types of structural systems for tall buildings, Shear Walls and their arrangement. Loads on Tall Buildings, Gravity loads, live loads, wind loads and seismic loading, Code Provisions. Discussion of relevant codes of practices and loading standards. Analysis off Tall Buildings with and without Shear Walls, Approximate analysis for gravity loads, lateral loads. Analysis of tube-in-tube constructional and 3-Dimensional analysis of shear core buildings, stability, stiffness and fatigue, factor of safety and load factor, Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Course Outcome:

- Structural elements and types of structural elements for tall buildings.
- Analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Books Recommended:

1 Schumelles W "High rise Building Structures" John Wiley and Sons, New York, 1977.
2. Ghali A "Structural Analysis: A Unified Classical and Matrix Approach" E & F Spon, London, 1999.
3. Taranath B S "Structural Analysis & Design of Tall Buildings" McGraw – Hill International, New York, 1988.
4. Brester B and Lin T Y "Steel Structures" John Wiley and Sons, New York, 1981.
5. Coull and Stafford S "Tall Buildings with Particular Reference to Shear Wall Structures" Pergamon Press, New York, 1967.

CE-526 Construction Methods and Equipment [3-0-0-3]

Course Objective:

- Properly select heavy equipment based on applications, utilization, productivity, and other factors
- Understand the elements of equipment cost and evaluating equipment owning alternatives.
- Have a basic understanding of various aspects of construction and earthwork, including but not limited to: concrete construction, Pile driving, tunneling, construction equipment and dewatering.

Course Syllabus:

Factors affecting selection of equipment technical and economic, construction engineering fundamentals, Analysis of production outputs and costs, characteristics and performances of equipment for Earth moving, Erection, Material transport, Pile driving, Dewatering, Concrete construction (including batching, mixing, transport and placement) and Tunneling.

Course Outcome:

- Learn how to best utilize construction equipment on site work and heavy civil projects.
- Become familiar with construction methods, equipment and their capabilities.
- Understand standard designations, sizes, and gradations of equipment.

Books Recommended:

1. Purifoy R L and Clifford J S "Construction Planning, Equipment and Methods: McGraw Hill, New York, 2002.

2. Verma M “Construction Equipment and its Planning and Application” Metropolitan Book company, New Delhi, 1994.
3. Singh J “Heavy Construction Planning, Equipment and Methods” Oxford and IBH, New Delhi, 1992.
4. NICMAR ‘Millennium Directory of Construction Equipment and Machinery Manufactured in India” CIRC, NICMAR, 2001.

CE-527 Design of Industrial Structures [3-0-0-3]

Course Objective:

- To qualify the students to analyse and design of various types of industrial buildings and to understand the design concept of Cold–formed light gauges steel sections.
- To understand the design concept of chimneys, cooling towers and bunkers
- To understand the design concept of trussed girder bridges and bearing
- To develop clear understanding of the concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.

Course Syllabus:

Planning of industrial structures, Design of braced and unbraced industrial portals in steel, Design of gantry girder, Design of single and multi bay industrial sheds in steel and concrete. Design of tie rods, sag rods, grit angles and purlins under action of dead, live and wind loads. Design of chimneys under combination of dead load, wind load and temperature stresses, Design of masts and cooling towers, Design of storage structures like bunkers and silos using Airy’s and Jensen’s theories. Design of large span roof structures and suspension roof structures, Machine foundations, Design of foundations for impact and rotary and reciprocating type machines. Analysis and design of Virendeel Girders.

Course Outcome:

- Capable of designing the industrial buildings with and without crane girders and students are capable enough to scrutinise the analysis and design of various industrial structures.
- Capable of designing the elements of steel construction.

- Capable of providing the design of concrete –Steel composite sections.
- Able to understand the analysis and design of trussed girder bridges and bearing.
- Able to analyze and design steel chimney, lattice tower and students able to independently design steel structures using relevant IS codes

Books Recommended:

1. Krishna Raju N "Advanced Reinforced Concrete Design" CBS Publishers, New Delhi, 2001.
2. Chandra R "Design of Steel Structures" Vol. II, Standard Publishers, Delhi, 1991.
3. Dayaratnam. P, "Design of Steel Structures" Wheeler Publishers, Allahabad, 1996.

CE-528 Advanced Steel Design [3-0-0-3]

Course Objective:

- To make students able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- To make students knowledgeable about the different configurations and components of elevated circular tanks.
- To make students aware about the design of light gauge steel.

Course Syllabus:

Plastic Design, Plastic Hinge, Plastic Collapse Load, Plastic Analysis of Frames; Wind Loads on Industrial Buildings, Braced and Unbraced Industrial Frames; Transmission Line Towers, Analysis by Tension Coefficients, Member Selection; Steel Tanks and Stacks, Different Configurations and components of Elevated Circular Tanks; Steel Stacks, Design Considerations; Design in Light Gauge Steel; Aluminum Structures; Residual Stresses.

Course Outcome:

- Able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- Different configurations and components of elevated circular tanks.
- Design of light gauge steel.

Books Recommended:

1. Dayaratnam P "Design of Steel Structures" Wheeler Publishers, Allahabad, 1996.
2. Arya A S and Ajmani J L "Design of Steel Structures" Nem Chand & Bros.,

Roorkee, 1996.

3. Raz S A “Structural Design in Steel”, New Age International Publishers, New Delhi, 2002.

4. Neal B G “Plastic Analysis of Structures” Chapman Hall, London, 1977

CE-529 Soil Dynamics and Machine Foundations [3-0-0-3]

Course Objective:

- Identification of dynamic loads and their characteristic.
- To apply theories of vibrations.
- Able to determine dynamic soil parameters.
- Understand the concept of Vibration isolation and screening.

Course Syllabus:

Nature of dynamic loads, stress conditions on Soil elements under E.Q. loading, Theory of vibrations, Behaviour of retaining walls during earthquakes, modification of Coulomb’s theory, Modified Culmann’s construction, Analytic solution for C- □□soils, Indian Standard Code of Practice, General, Failure Zones & ult. B.C. criteria for satisfactory action of a footing, Earthquakes loads on footings. Dynamic analysis for vertical loads, Theory, criterion of liquefaction, factor affecting, Laboratory studies on liquefaction in Triaxial shear and Oscillatory simple shear, Evaluation of Liquefaction Potential, Vibration table studies, Liquefaction behaviour of Dense sands, Introduction, Criteria for a satisfactory M/C foundation, Methods of analysis, Degrees of freedom of a Block foundation, soil spring stiffness, vibrations of a block I.S. for design of reciprocation M/c design procedure for Block Foundation, Vibration Isolation & Screening of Waves.

Course Outcome:

- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations.
- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Books Recommended:

1. Barken D D “Dynamics of Bases and Foundations” McGraw Hill, New York, 1962.
2. Saran S “Soil Dynamics and Machine Foundations”, Galogotia Publications Pvt. Ltd,New Delhi, 1999.
3. Rao N D V K “Vibration Analysis and Foundation Dynamics” Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi, 1998.
4. Prakash S “Soil Dynamics” McGraw Hill Book Company, New York, 1981.
5. Richart F E, Hall J R and Woods R D, “Vibrations of Soils and Foundations”, Prentice Hall International, N Jersey, 1970.
6. Krammer S “Geotechnical Earthquake Engineering” Pearson Education Pvt. Ltd. New Delhi, 2003.

CE-530 Construction and Contract Management [3-0-0-3]

Course Objective:

- To make Civil Engineering students able to analyze, evaluate and design construction contract documents.
- Resolve disputes collaboratively and amicably and outline alternative dispute resolution methods.

Course Syllabus:

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies, Qualification of bidders, Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, Conditions and specifications of contract. Contract administration, Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Cancellation Act 1996, Arbitration case studies, Professional ethics, Duties and responsibilities of parties, Management Information systems, Risk analysis, Value engineering.

Course Outcome:

Students will be able to

- Recognize different types of contracts and the effect of each type on the risk allocation strategy.

- Prepare contract schedules, notice inviting tender and contract documents.
- Apply contract administration tools and techniques to effectively manage the contract and avoid disputes during implementation.

Books Recommended:

1. Prakash V A "Contract Management in Civil Works Projects" NICMAR, 1997.
2. Richard C "Construction Contracting" John Wiley & sons, New York, 1986.
3. Ashworth A "Civil engineering Contractual Procedures" Longman, Harlow, 1998.
4. McCaffer R and Baldwin A N: Estimating and Tendering for Civil engineering works" Thomas Telford, London, 1991.
5. Thomas R "Construction Contract Claims" Macmillan, London, 1993.

CE 531 Geoenvironmental Engineering (3-0-0)

Course Objectives:

1. To make students aware about subsurface contamination and its sources
2. To make students learn about geotechnical aspects of planning and design of facilities for disposal of different kinds of solid waste
3. To make students learn about detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To make students learn about rehabilitation of waste dumps and geotechnical re-use of waste.

Course Syllabus:

Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and

field evaluation of permeability; Factors affecting permeability;

Waste disposal on land. Types of landfills : Sitting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.

Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

Course Outcomes:

Students will be to

- plan and design the facilities for disposal of different kinds of solid waste
- plan the detection and monitoring of subsurface contamination

Text and Reference Books:

1. Sharma, H. and Reddy, K.R., 2004. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Wiley.
2. Daniel, D.E., 1993. Geotechnical Practice for waste disposal. Chapman and Hall, London
3. Koerner, R.M., 2005. Designing with Geosynthetics. Prentice Hall, New Jersey
4. Reddi, L.N. and Inyang H.I., 2000. Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication

CE -532 Landfills And Ashponds (3-0-0)

Course Objectives

- To make students learn about design of waste disposal facilities
- To make students learn about the construction and operation of waste disposal facilities

Course Content

Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas. Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring. Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

Course outcomes

The student will be able to:

- To design the waste disposal facilities
- To contribute in construction and operation of the waste disposal facilities
- To plan the environmental monitoring around the waste disposal facilities.

Text and Reference Books:

1. Datta, M., 1998. Waste disposal in Engineered landfills, Narosa Publishers.
2. Reddy, L.N. and Inyang. H. I., 2000. Geoenvironmental Engineering –Principles and Applications, Marcel Dekker, Inc., New York
3. Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Townsend, T. G., 2015. Sustainable Practices for Landfill Design and Operation. Springer.

CE -533 Solid And Hazardous Waste Management (3-0-0)

Course Objectives

- To make students understand the components of solid waste management system
- To make students learn about recycling, reuse and reclamation of solid wastes

Course Content

Municipal Solid Waste : Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

Course outcomes

After this course student will be able to:

- To review the components of solid waste management system
- Appreciate the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste

- understand the importance and operation of a various facilities for resource recovery and waste disposal

Text and Reference Books:

1) Tchobanoglous, G., Vigil, S.A. and Theisen, H.,1993. Integrated Solid Waste Management: Engineering Principles and Management Issues, Mc-Graw Hill.
2) Pichtel, J., 2005. Waste Management Practices – Municipal, Hazardous and Industrial, CRC Press.
3) Vesilind, P.A., 2008. Solid Waste Engineering, Thomson Learning Inc.
4) Vesilind, P.A., Worrell, P.A., Reinhart, D., 2001. Solid Waste Engineering, Nelson Engineering.
5) Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.

CE-534 Concrete Mechanics [3-0-0-3]

Course Objective:

- To make students aware regarding the theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- To share the concepts of Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- To share the concepts of Statical and dynamical analysis of R. C. structures, trends.

Course Syllabus:

Introduction, Theological modeling of fresh concrete, Constitutive Equations: Nonlinear elasticity, plasticity, visco-elasticity and fracture mechanics of hardened concrete, confinement and ductility, Moisture diffusion: Permeability of Concrete, Drying creep and shrinkage cracking, solid and structural mechanics of reinforced concrete, Skew bending, modified compression field and unified theories of R.C. Beams under bending, shear and torsion, Bond-slip and phenomenon of cracking in reinforced concrete: Statical and dynamical analysis of R. C. Structures, Trends.

Course Outcome:

- Introduction, theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- Statical and dynamical analysis of R. C. structures, trends.

Recommended Books:

1. Jan G. M. van Mier “Fracture Processes of Concrete”, CRC Press; 1 edition, 1997.
2. Carpinteri A. and Ingraffea A. R. “Fracture mechanics of concrete: material characterization and testing”, Martinus Nijhoff Publishers, 1984.

CE-535 Recent Advances in Construction Materials [3-0-0-3]

Course Objective:

- To introduce the students with various types of construction materials required in specific places and situations.
- To provide the knowledge regarding construction of infrastructure with the use of these materials that involves designing the constituents, mixes and gradations.
- To gain knowledge regarding use of cheap alternative materials in place of high cost construction materials.

Course Syllabus:

Foams and lightweight materials, fibre reinforced concrete. Types of fibres, workability, mechanical and physical properties of fibre reinforced concrete, Industrial waste materials in concrete, their influence on physical and mechanical properties and durability of concrete, Concrete at high temperature, High strength concrete, changes in concrete with time, corrosion of concrete in various environments, corrosion of reinforcing steel, electro chemical process, measures of protection, Ferro-cement, materials and properties polymers Civil Engineering Polymers, fibres and composites, fibre reinforced plastic in sandwich panicles, modeling. Architectural use and aesthetics of composites. Adhesives and sealants. Structural elastomeric bearings and resilient seating. Moisture barriers, polymer foams and polymers in building Physics, Polymer concrete composites.

Course Outcome:

- The students will be able to make use of specific materials required for a given construction work.
- Course will enable them to decide the materials on basis of service life and expected performance on basis of their properties.

Recommended Books:

1. Marios, S. and Peter, D. 2017. Construction Materials: their nature and behavior, CRC Press.
2. David, D., and Cather, B. 2013. Construction materials reference book, Routledge.
3. Zhang, H. 2011. Building materials in civil engineering, Woodhead Publishing Series in Civil and Structural Engineering.
4. Hornbostel, C. 1991. Construction materials: types, uses and applications, John Wiley & Sons.
5. Duggal, S.,K. 1998. Building materials, New age international.
6. **Grosse**, Christian U., 2007. Advances in construction materials, **Grosse**, Christian U. (Ed.), Springer.

CE-536 Composite Materials [3-0-0-3]

Course Objective:

- To make students aware about the definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- To make students knowledgeable regarding the role of fibers in composites, comparison of fibres, role of interface in the fibre matrix composite.
- To make analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.

Course Syllabus:

Definition of Composite Materials, Classification of Composite Materials, Role of matrix in a composite materials, Polymer matrices, Classification of Polymer, Metal Matrices, Ceramic matrices, Comparison of polymer matrix, Metal matrix and ceramic Matrix, Role of fibres in composites, Comparison of Fibres, Role of interface in the fibre matrix composite.

Characterization of composites, Analysis of an Orthotropic Lamina and laminated Composites, Elastic properties of Unidirectional Laminate, cross ply laminate, Angle ply laminates, Short fibre composite materials, Experimental Characterization of Composites.

Course Outcome:

- Definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- Role of fibres in composites, comparison of fibres, role of interface in the fibre matrix composite.
- Analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.

Recommended Books:

1. Chawla, Krishan K. "Composite Materials: Science and Engineering (Materials Research and
2. Engineering)", Springer; 3rd edition, 2013.
3. Brandt A. M. "Cement-based Composites: Materials, Mechanical Properties and Performance", CRC Press, 1994.
4. Yang Y., Yu J., Xu H. and Sun B. "Porous lightweight composites reinforced with fibrous structures", Springer; 1st edition, 2017.

CE-537 Simulation & Modelling [3-0-0-3]

Course Objective:

- To impart the fundamental knowledge on using various analytical tools like STAAD Pro, ABAQUS, etc., for Engineering Simulation.
- Engineering problem modelling and solving through the relationship between theoretical, mathematical, and computational modelling for predicting and optimizing performance and objective.
- To impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools.

- Develop solutions and extract results from the information generated in the context of the engineering domain to assist engineering decision making.

Course Syllabus:

Introduction: Mathematical models, numerical models and Physical models. Deterministic and stochastic models. Concepts of simulation.

Competitive situations: Optimization, Single and multiple objectives optimizations, Pareto optimal solutions. Introduction to linear and geometric programmings. Zero degree and single degree of difficulty.

Growth and Decay processes: Discrete and continuous systems. Differential and Integral equation approach, Fibonacci growth.

Probability Distributions: Binomial and Poisson distributions, Normal, Lognormal and pareto distributions.

Generation of random numbers: Uniform variable, normal and lognormal variables.

Queing theory: Montecarlo methods, solutions of Laplace equations in two dimensions.

Course Outcome:

- The student will be able to appreciate the utility of the tools like STAAD Pro or ABAQUS in solving real time problems and day to day problems.
- Use of these tools for any engineering and real time applications.
- Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.

Recommended Books:

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, Discrete Event system Simulation, Pearson Education, Asia, 4th Edition, 2007, ISBN: 81-203-2832-9.

2. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4.

3. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.

4. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN: 0-87692-028-8.

CE-538 Site Investigations and Ground Improvement [3-0-0-3]

Course Objective:

- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

Course Syllabus:

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions. Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Report writing. Safety measures.

Geotechnical Processes: Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control. Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.

Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis, lime column. soil-lime column. Grouting: permeation, compaction and jet. Vibro floatation, dynamic compaction, thermal, freezing. Dewatering systems.

Course Outcome:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization.

- Students will learn about geosynthetics and their properties.
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Recommended Books:

1. Peck R B, Hanson W B and Thorn Burn T H "Foundation Engineering" John Wiley and Sons Inc, New York, 1974.
2. Teng W C "Foundation Design" Prentice Hall of India Pvt. Ltd., New Delhi, 1977.
3. Bowles J E "Foundation Analysis and Design" McGraw Hill, New York, 1982.
4. Saran S "Analysis and Design of Substructures", Oxford & IBH Publishing Co. (P) Ltd., New Delhi, 1996.
5. Coduto, Donald P"Foundation Design", Pearson Education International, New Jersy, 2001

CE-539 Engineering Behaviour of Soils [3-0-0-3]

Course Objective:

- To understand the mechanical stress, strain and strength of soil.
- To understand the critical state soil mechanics.
- Apply fundamental knowledge of the behaviour of soil as an engineering material in Civil Engineering Projects.
- Analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Course Syllabus:

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure. Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability. Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters.

Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters.

Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters. Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours. Factors affecting strength : stress history, rate of testing, structure and temperature. Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength. Stress-strain characteristics of soils. Determination modulus values. Critical state model.

Engineering Behaviour of soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

Course Outcome:

- Students will be able to determine the stress, strain of soil, critical state of soil.
- Students will have knowledge regarding the behaviour of soil as an engineering material in Civil Engineering Projects.
- Students will learn to analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Books Recommended:

1. Mitchell, James K., (1993), "Fundamentals of soil Behaviour", 2nd Edition, John Wiley and sons.

2. Das, B.M., (1997), "Advanced soil Mechanics", Taylor and Francis.

3. Lambe, T.W., and Whitman, R.V., (1987), "Soil Mechanics", John Wiley and Sons.

4. Gulhati, Shashi K., and Datta Manoj (2008), "Geotechnical Engineering, Tata Mcgraw-Hill Company Ltd.

5. Coduto, Donald P (2002), "Geotechnical Engineering, Principles and Practices",
Pearson Education International, New Jersy.

CE-540 Geosynthetics [3-0-0-3]

Course Objective:

- Understand different the basics of Geosynthetics
- Identify the geosynthetic materials and its applications.
- To get familiar with using different geosynthetics for improvement of bearing capacity and soil texture.

Course Syllabus:

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences. Geosynthetics in Pavements:

Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.

Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

Course Outcome:

- Students should be able to distinguish between different geosynthetics.
- Students should be able to determine the properties of geosynthetics.
- Students should be able to determine the bearing capacity of soil after introducing geosynthetics.

Recommended Books:

1. Rao G V and Raju S "Engineering with Geosynthetics" Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990.
2. Ranjan G and Rao A S R "Basic and Applied Soil Mechanics" International Publishers, New Delhi, 2000.
3. Koerner R M "Designing with Geosynthetics" Prentice-Hall, N. J., U.S.A., 1986.
4. Saran, S., (2006), "Reinforced soil and its Engineering Applications", I.K. International Pvt. Ltd.
5. Jones, C.J.F.P. (1985), "Earth Reinforcement and soil structures", Butterworth and co. (Publishers) Ltd., London, England.

CE-541 Pavement Analysis, Design and Construction (3-0-0-3)

Course Objectives

1. To study the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations.
4. To introduce the constructions of different types of highway pavements.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Course Syllabus

Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories , ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.

Flexible Pavement Design: Various approaches for designing the highway and airport pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements (highways and airports) and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods, design of joints

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement consruction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc.

Evaluation and Strengthening:

Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, overview of the revision of specifications pertaining to these methods, design of different overlays, skid resistance and measurement

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of low volume roads.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;
5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
4. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
5. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
6. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
7. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
8. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.

9. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.
10. Chakraborty, P. and Das, A., 2013. Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).
10 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

11. Yoder E.J. and Witzack M.W., 1991. Principles of Pavement Design; John Wiley and Sons, New York.
12. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi
13. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
14. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
15. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.
IRC: 58-2015. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.
IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi
IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

ID 601 Research Methodology [3-0-0-3]

Course Objectives:

- To understand research and research process.
- To acquaint students with identifying problems for research and develop research strategies.
- To familiarize students with the techniques of data collection, analysis of data and interpretation.

Course Syllabus:

Thinking Process: role of thinking in research, levels and styles of thinking, common sense and scientific thinking, examples.

Problem solving: problem solving strategies- reformulation or rephrasing, techniques of representation, logical thinking, division into sub problems, verbalization, awareness of scale, importance of graphical representation, examples.

Experimental and modelling skills: census and sample survey, sampling procedure, important scaling techniques, methods of data collection, estimation and reduction of random errors, detection and elimination of systematic error, guideline for constructing questionnaire, scientific method role of hypothesis in experiment, hypothesis testing, F test, t-test, chi square test, use of ANOVA.

Types of models, the art of making approximations, problem representation, logical reasoning, mathematical skills, techniques of numerical simulation.

Problem finding and literature survey: information gathering reading searching and documentation, types, attributes and sources of research problem; problem formulation, relative importance of various forms of publication; choice of journal entries using process, difference between publishing and patenting.

Effective communication-oral and written: examples in straightening the importance of effective communication, stages and dimensions of a communication process.

stress management time management interpersonal skills professional ethics: psychological faces of a PhD process, stress points, managing self, teamwork, sense of humor, plagiarism and research ethics.

Course Outcome:

Learner will be able to…

- Prepare a preliminary research design for projects in their subject matter areas.
- Accurately collect, analyze and report data.
- Present complex data or situations clearly.
- Review and analyze research findings.

Recommended Books:

1. E.M. Phillips and D S Pugh, ― How to get a PhD – a handbook for PhD student s and their supervisors, Viva books Pvt. Ltd for all scholars irrespective of their disciplines.
2. Handbook of Science Communication, compiled by Antony Wilson, Jane Gregory, Steve Miller, Shirley Ear, Overseas Press Indian Pvt. Ltd, New Delhi, first edition 2005.
3. G L Squires, ―Practical physics, Cambridge University Press for all scholars except those from Humanities and Management sciences.
4. Peter B Medeq, ― Advice to a Young Scientist, Pan Books, London 1979.

CE 590 Modelling and Research Methodology [3-0-0-3]

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Syllabus:

UNIT –I Research methodology

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

UNIT –II Literature survey

Importance of literature survey -Sources of information -Assessment of quality of journals and articles -Information through internet. Literature review: Need of review -Guidelines for review -Record of research review.

UNIT –III Research design

Meaning of research design -Need of research design -Feature of a good design -Important concepts related to research design -Different research designs -Basic principles of experimental design -Developing a research plan -Design of experimental set-up -Use of standards and codes of Civil Engineering.

UNIT –IV Data collection and analysis:

Collection of primary data and Secondary data of different Civil Engineering fields -Data organization -Methods of data grouping -Diagrammatic representation of data -Graphic representation of data -Sample design -Need for sampling -Some important sampling definitions -Estimation of population -Role of statistics for data analysis -Parametric vs. non parametric methods -Descriptive statistics -Measures of central tendency and dispersion -Hypothesis testing -Use of statistical softwares. Data Analysis: Deterministic and random data -Uncertainty analysis -Tests for significance -Chi-square -Student’s t-test -Regression modeling -Direct and interaction effects –ANOVA-F-test -Time series analysis -Autocorrelation and autoregressive modeling.

UNIT –V Research report writing:

Format of the research report –Synopsis –Dissertation -Thesis -Its differentiation –References –Bibliography -Technical paper writing -Journal report writing -Making presentation -Use of visual aids. Research proposal preparation: Writing a research proposal and research report -Writing research grant proposal.

Course Outcome:

- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.

- Process research data to write research report for grant proposal.

Recommended Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. 2002. An introduction to research methodology, RBSA Publishers.
2. Kothari, C.R, 2004. Research methodology, methods & technique, New Age International Publishers, New Delhi.
3. Ganesan, R. 2015. Research methodology for engineers, MJP Publishers, Chennai.
4. Khananabis, Ratan and Saha, Suvasis 2015. Research methodology, Universities Press, Hyderabad.
5. Agarwal,Y.P. 2004. Statistical Methods: concepts, application and computation, Sterling Publishing Pvt. Ltd., New Delhi.
6. Upagade, Vijay and Shende, Aravind 2009. Research methodology, S. Chand & Company Ltd., New Delhi.
7. Nageswara Rao, G. 2012. Research methodology and quantitative methods, BS Publications, Hyderabad.

Teaching scheme and syllabus for M.Tech. (Geotechnical & Geoenvironmental Engineering)

Enclosure #4

CURRICULUM

M. TECH.
in
GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING

(July 2019 admission onwards)

APPROVED BY

BOARD OF STUDIES (BOS)
12th MEETING, February 20, 2019

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

Teaching Scheme

Semester – I*

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - I	3	0	0	3
CE	Course - II	3	0	0	3
CE	Course - III	3	0	0	3
CE	Course - IV	3	0	0	3
CE	Course - V	3	0	0	3
CE	Lab-I	0	0	3	2
CE	Lab-II	0	0	3	2

Semester - II

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - VI	3	0	0	3
CE	Course - VII	3	0	0	3
CE	Course - VIII	3	0	0	3
CE	Course - IX	3	0	0	3
CE	Course - X	3	0	0	3
CE	Lab-III	0	0	3	2
CE	Lab-IV	0	0	3	2
Total					19

Semester – III*

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - XI	3	0	0	3
CE	Course - XII	3	0	0	3
CE	Independent Study	0	0	6	3
CE	Dissertation Part I	0	0	12	6*
Total					**15**

Note: 8 Core courses including Independent study and Dissertations and 6 elective courses need to be completed for the degree.

Semester – IV@

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Dissertation Part II	0	0	24	12*
Total		0	0	24	**12**

@*The result of Dissertation Part I & II shall be forwarded cumulatively after evaluation of dissertation*

Grand Total of Credits = 65

List Of Core Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-539	Engineering Behaviour Of Soils	3	0	0	3
2.	CE-551	Design Of Substructures	3	0	0	3
3.	CE-552	Soil Dynamics And Earthquake Engineering	3	0	0	3
4.	CE-531	Geoenvironmental Engineering	3	0	0	3
5.	CE-533	Solid And Hazardous Waste Management	3	0	0	3
6.	CE-513	Advanced Numerical Methods	3	0	0	3
7.	CE-601	Independent Study	0	0	6	3
8.	CE-600	Dissertation Part-I Dissertation Part-II	0	0	30	6+12

List Of Laboratory Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-561	Materials Testing And Characterization Laboratory	0	0	2	1
2.	CE-562	Soil Engineering Laboratory	0	0	2	1
3.	CE-563	Advanced Water And Wastewater Laboratory	0	0	2	1
4.	CE-564	Simulation Laboratory	0	0	2	1

List Of Elective Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-501	Advanced Solid Mechanics	3	0	0	3
2.	CE-540	Geosynthetics	3	0	0	3
3.	CE-532	Landfills And Ashponds	3	0	0	3
4.	CE-553	Environmental Risk Assessment	3	0	0	3
5.	CE-554	Finite Element Method in Geotechnical Engineering	3	0	0	3
6.	CE-555	Subsurface Hydrology	3	0	0	3
7.	CE-556	Mechanics of Sediment Transport	3	0	0	3
8.	CE-557	Water Resources Systems	3	0	0	3
9	CE-558	Geotechnical Investigations and Ground Improvement	3	0	0	3
10	CE-559	Earth Dams and Stability Of Slopes	3	0	0	3
11	CE-560	Emerging Topics In Geotechnical Engineering	3	0	0	3
12	CE-566	Pavement Geotechnics and Material	3	0	0	3
13	CE-567	Rock Mechanics	3	0	0	3
14	CE-568	Engineering Geology	3	0	0	3
15	CE-569	Environmental Impact Assessment	3	0	0	3
16	CE-570	Environmental System Analysis	3	0	0	3
17	CE-571	Risk and Reliability in Geotechnical Engineering	3	0	0	3
18	CE-572	Constitutive Models for Soil	3	0	0	3
19	CE-573	Natural Treatment Systems	3	0	0	3
20	CE-541	Pavement Analysis, Design and Construction	3	0	0	3

21	CE-574	Watershed Management and Remote Sensing Applications	3	0	0	3
22	CE-590	Modelling and Research Methodology	3	0	0	3

SYLLABUS

CE 539 Engineering Behaviour of Soils (3-0-0)

Course Objectives

- To understand the mechanical stress, strain and strength of soil
- To understand the critical state soil mechanics
- Apply fundamental knowledge of the behaviour of soil as an engineering material in Civil Engineering Projects
- Analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement

Course Syllabus

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure.
Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability.
Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters.
Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters.
Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours. Factors affecting strength : stress history, rate of testing, structure and temperature.
Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength.
Stress-strain characteristics of soils. Determination modulus values.
Critical state model. Engineering Behaviour of soils of India : Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

Course outcomes

- Students will be able to determine the stress, strain of soil, critical state of soil
- Students will have knowledge regarding the behaviour of soil as an engineering material in Civil Engineering Projects
- Students will learn to analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement

Text and Reference Books:

1. Mitchell, J. K., 1993. Fundamentals of soil Behaviour. Edition, John Wiley and sons, New York
2. Das, B.M., 1997. Advanced soil Mechanics. Taylor and Francis.
3. Lambe, T.W. and Whitman, R.V., 1987. Soil Mechanics. John Wiley and Sons
4. Gulhati, S. K. and Datta M. 2008. Geotechnical Engineering. Tata Mcgraw-Hill Company Ltd.

5. Coduto, D. P. 2002. Geotechnical Engineering, Principles and Practices. Pearson Education International, New Jersey.

CE 551 Design of Substructures (3-0-0)

Course Objectives:

- To be able to develop deeper understanding of shallow and deep foundations
- To be able to develop understanding of different design parameters
- To be able to design reinforced retaining wall

Course Syllabus:

Shallow Foundations: Depth, Spacing of footings, Erosion problems, Water table effects, foundations on sands, Silts, Clays, landfills (qualitative treatment only). Introduction to design of Spread footings, Rectangular footings, and Eccentrically loaded spread footings, Basics of beams on elastic foundation and Ring foundations.

Mat Foundations: Types, Bearing capacity, Settlements, Sub grade reaction, Design guidelines.

Deep Foundations: Tension piles, Negative skin friction, and under-reamed piles. Guidelines for design of pile caps, Batter piles, Laterally loaded piles- Ultimate capacity of laterally loaded piles. Drilled piers – Uses, load carrying capacity, Settlements.

Retaining Walls, MSE Walls, Sheet Piles, Well Foundations, Cofferdams

Course Outcomes:

- Students should be able to design shallow and deep foundations
- Students should be able to determine different design parameters
- Students should be able to design reinforced retaining wall

Text and Reference Books:

1. Das, B.M., 1999. Principles of Foundation Engineering. Cengage Learning, Singapore.
2. Bowles, J. E. 1988. Foundation Analysis and Design. Mc Graw Hill, New York.
3. Swami, S., 2009. Analysis and Design of Substructures. Oxford & IBH Publishing Company Pvt. Ltd.

CE 552 Soil Dynamics And Earthquake Engineering (3-0-0)

Course Objectives:

1. Identification of dynamic loads and their characteristic.
2. To apply theories of vibrations.
3. Able to determine dynamic soil parameters.
4. Understand the concept of Vibration isolation and screening.

Course Syllabus:

Nature of dynamic loads, stress conditions on Soil elements under E.Q. loading,
Theory of vibrations, Behaviour of retaining walls during earthquakes, modification of Coulomb's theory, Modified Culmann's construction,
Analytic solution for C- ϕ soils, Indian Standard Code of Practice, General, Failure Zones & ult. B.C. criteria for satisfactory action of a footing, Earthquakes loads on footings.
Dynamic analysis for vertical loads, Theory, criterion of liquefaction, factor affecting, Laboratory studies on liquefaction in Triaxial shear and Oscillatory simple shear, Evaluation of Liquefaction Potential, Vibration table studies,Liquefaction behaviour of Dense sands,

Introduction, Seismology and earthquakes, continental drift and plate tectonics, elastic Rebound theory, location and size of earthquakes. Ground motion parameters & their estimation, Seismic Hazard Analysis - Deterministic and Probabilistic. Wave Propagation,
Ground Response Analysis - one, two and three dimensional ground response analysis.

Introduction, Criteria for a satisfactory M/C foundation, Methods of analysis, Degrees of freedom of a Block foundation, soil spring stiffness, vibrations of a block I.S. for design of reciprocation M/c design procedure for Block Foundation, Vibration Isolation & Screening of Waves.

Course Outcomes:

- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations

- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Text and Reference Books:

1. Barken, D. D.,1962. Dynamics of bases and foundations. McGraw Hill, New York.
2. Saran, S., 1999. Soil Dynamics and Machine Foundations. Galogotia Publications Pvt. Ltd, New Delhi.
3. Rao, N. D. V. K., 1998. Vibration Analysis and Foundation Dynamics. Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi.
4. Krammer, S., 2003. Geotechnical Earthquake Engineering. Pearson Education Pvt. Ltd. New Delhi.
5. Prakash, S., 1981. Soil Dynamics. McGraw Hill Book Company, New York.

CE 531 Geoenvironmental Engineering (3-0-0)

Course Objectives:

1. To make students aware about subsurface contamination and its sources
2. To make students learn about geotechnical aspects of planning and design of facilities for disposal of different kinds of solid waste
3. To make students learn about detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To make students learn about rehabilitation of waste dumps and geotechnical re-use of waste.

Course Syllabus:

Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability;

Waste disposal on land. Types of landfills : Sitting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.

Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

Course Outcomes:

Students will be to

- plan and design the facilities for disposal of different kinds of solid waste
- plan the detection and monitoring of subsurface contamination

Text and Reference Books:

1. Sharma, H. and Reddy, K.R., 2004. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Wiley.
2. Daniel, D.E., 1993. Geotechnical Practice for waste disposal. Chapman and Hall, London
3. Koerner, R.M., 2005. Designing with Geosynthetics. Prentice Hall, New Jersey
4. Reddi, L.N. and Inyang H.I., 2000. Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication

CE -533 Solid And Hazardous Waste Management (3-0-0)

Course Objectives

- To make students understand the components of solid waste management system
- To make students learn about recycling, reuse and reclamation of solid wastes

Course Content

Municipal Solid Waste : Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

Course outcomes

After this course student will be able to:

- To review the components of solid waste management system
- Appreciate the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste
- understand the importance and operation of a various facilities for resource recovery and waste disposal

Text and Reference Books:

1) Tchobanoglous, G., Vigil, S.A. and Theisen, H.,1993. Integrated Solid Waste Management: Engineering Principles and Management Issues, Mc-Graw Hill.
2) Pichtel, J., 2005. Waste Management Practices – Municipal, Hazardous and Industrial, CRC Press.
3) Vesilind, P.A., 2008. Solid Waste Engineering, Thomson Learning Inc.
4) Vesilind, P.A., Worrell, P.A., Reinhart, D., 2001. Solid Waste Engineering, Nelson Engineering.
5) Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.

CE 513 Advanced Numerical Methods (3-0-0)

Course Objective:

- To understand the different numerical methods
- To be able to use different numerical methods for solving various geotechnical problems

Course Syllabus:

Introduction Solutions to linear equations, properties of matrices, Eigen values and Eigen vectors, solutions of linear systems; direct methods and iterative methods, Computation of Eigen values, solutions to the problems using programming languages (C, C++, FORTRAN, MATLAB)

Solutions of non linear equations, importance of non linear equations, different numerical techniques to solve non-linear equations (Newton Raphson method, secant method, Aitken method)

Approximation of functions. Introduction, Taylor series, least squares, legendre polynomials, regression analysis

Numerical differentiation and integration, ODE and PDE, truncation errors

Course Outcomes:

- Student should be able to use different numerical methods for solving various geotechnical problems

Text and Reference Books:

1. Chapra, S. C. and Canale R. P., 2003. Numerical Methods for Engineers. Tata McGraw Hill
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., 1969. Applied Numerical Methods", John Wiley
3. Heath, M. T., 1997. Scientific Computing : An Introductory Survey. McGraw Hill
4. Rajasekaran, S., 1999. Numerical Methods in Science and Engineering. S. Chand

CE 501 Advanced Solid Mechanics (3-0-0)

Course Objectives:

Course Syllabus:

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

Course Outcomes:

Text and Reference Books:

1. Timoshenko S P and Goodier J N "Theory of Elasticity" McGraw Hill, New York, 2002.
2. Housner G W and Vreeland J R "The Analysis of Stress and Deformation" Mcmillan London, 1998.
3. Srinath L S "Advanced Mechanics of Solids" Tata Mcgraw Hill, New Delhi, 2000.
4. Westergaard H M "Theory of Elasticity and Plasticity" Harvard University Press,

Cambridge, 1998.
5. Kazimi S M A “Solid Mechanics” Tata McGraw Hill, New Delhi, 1999.

CE -532 Landfills And Ashponds (3-0-0)

Course Objectives

- To make students learn about design of waste disposal facilities
- To make students learn about the construction and operation of waste disposal facilities

Course Content

Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas. Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring. Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

Course outcomes

The student will be able to:

- To design the waste disposal facilities
- To contribute in construction and operation of the waste disposal facilities
- To plan the environmental monitoring around the waste disposal facilities.

Text and Reference Books:

1. Datta, M., 1998. Waste disposal in Engineered landfills, Narosa Publishers.
2. Reddy, L.N. and Inyang. H. I., 2000. Geoenvironmental Engineering –Principles and Applications, Marcel Dekker, Inc., New York
3. Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Townsend, T. G., 2015. Sustainable Practices for Landfill Design and Operation. Springer.

CE 540 Geosynthetics (3-0-0)

Course Objectives:

- Understand different the basics of Geosynthetics
- Identify the geosynthetic materials and its applications.
- To get familiar with using different geosynthetics for improvement of bearing capacity and soil texture

Course Syllabus:

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences.

Geosynthetics in Pavements:

Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.

Geosynthetics in Environmental Control:

Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

Course Outcomes:

- Students should be able to distinguish between different geosynthetics
- Students should be able to determine the properties of geosynthetics
- Students should be able to determine the bearing capacity of soil after introducing geosynthetics

Text and Reference Books:

1. Shukla, S. K. and Yin, J. H., 2006. Fundamentals of Geosynthetics Engineering. Taylor and Francis.
2. Shukla, S. K., 2002. Geosynthetics and their Applications. Thomson Telford.
3. Han, J.,1964. Principles and Practices of Ground Improvement. John Wiley & Sons, Inc., New Jersey.
4. Rao, G. V. and Raju, S., 1990. Engineering with Geosynthetics. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Koerner, R. M., 1986. Designing with Geosynthetics. Prentice-Hall, N. J., U.S.A.
6. Saran, S., 2006. Reinforced soil and its Engineering Applications. I.K. International Pvt. Ltd.

CE 553 Environmental Risk Assessment (3-0-0)

Course Objectives

- To introduce concepts of environmental risk assessment to the students
- To teach mathematical approaches to quantify different risk assessment components.

Course Content

Basic concepts of environmental risk and definitions; Human health risk and ecologial risk assessment framework; Hazard identification procedures and hazard prioritization; Environmental risk zonation; Consequence analysis and modelling (discharge models, dispersion models, fire and explosion models, effect models etc). Estimation of incident frequencies from historical data, frequency modelling techniques e.g., Fault tree analysis (FTA) and Event tree analysis (ETA), Reliability block diagram. Case Studies. Human factors in risk analysis; Risk management & communication. Rules, regulations and conventions.

Course outcomes

The student will be able to:

- To understand the concept of environment risk assessment.
- To implement mathematical tools to assess environmental risk .

Text and Reference Books:

1. Devore, J.L., Probability and Statistics for Engineering and the Science. Latest edition, Thomson Learning Inc.
2. Kammen, D.M., and Hassenzahal, D.M., Should we risk it?: Exploring environmental, health, and technological problem solving. Latest edition, Princeton University Press.
3. DeGroot, M.H. and Schervish, M.J. Probability and Statistics. Latest edition, Addison-Wesley.
4. Johnston, J. and DiNardo, J., Econometric methods. Latest edition, The McGraw-Hill Companies, Inc.

CE 554 Finite Element Method in Geotechnical Engineering (3-1-0)

Course Objectives:

- To implement the basics of FEM to relate stresses and strains.
- To solve one, two and three dimensional and dynamic problems using Finite Element Analysis.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements;
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Syllabus:

Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, Some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

Course Outcome:

- Implement numerical methods to solve mechanics of solids problems.
- Formulate and Solve axially loaded bar Problems.
- Formulate and analyze truss and beam problems.
- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
- Formulate and solve Axi-symmetric and heat transfer problems.

Text and Reference Books:

1. Zienkiewiez O. C., 1991. The Finite Element Method. Mcgraw Hill, London.
2. Abel, J. F. and Desai, C. A., 2004. Finite Element Method. Van Nostrand Reinhold, New York.
3. Reddy, J.N., 2003. An Introduction to the Finite Element Method. Tata McGraw Hill, New Delhi.
4. Bathe, K. J. 1997. Finite Element Procedures. Prentice Hall of India Private Limited, New Delhi.
5. Chandrupatla, T. R. and Belegundu, A. D. 1997. Introduction to Finite Elements in Engineering" Prentice Hall of India Private Limited, New Delhi.

CE 555 Subsurface Hydrology (3-0-0)

Course Objectives:

- To understand the mechanism of ground water flow
- To get familiar with transport processes in porous media
- To identify the sources of ground water

Course Syllabus:

Fundamentals of subsurface flow and transport, role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Groundwater recharge, water logging and salinity; infiltration and exfiltration from soils in absence and presence of a water table; modelling contaminant transport through porous media: dispersion, adsorption and decay, volatilization; applications of numerical models (GMS, FEFLOW, PMWIN, etc.) in hydrogeology; model conceptualization, discretization and calibration, initial and exit boundary conditions.

Text and Reference Books:

1. Bear, J., Dynamics of Fluids in porous Media, Dover Publications, 1972.
2. Fetter, C.W., Contaminant Hydrogeology, Prentice Hall, 1999.
3. Bear, J. and Verruijt, A., Modelling Groundwater Flow and Pollution, Reidel Publishing Company, 1990.
4. Fetter, C.W., Applied Geohydrology, Prentice Hall, 2001.

Course Outcomes:

- Students should be able to distinguish amongst ground water and surface water
- Students should be able to quantify the flow in groundwater in different saturated zones.
- Students should be able to determine the quality and quantity of ground water and its sources.

CE 556 Mechanics of Sediment Transport (3-0-0)

Course Objectives:

- To understand the mechanism of sediment transport
- To get familiar with the dynamics of natural streams
- To know about behaviour and maintenance of open channels

Course Syllabus:

Fluvial sediments; transportation and entrainment; physical & chemical characteristics; grain size distribution;

Introduction to sediment: Physical properties of fluid and sediment, origin and properties of sediments, nature of problems.

Fluvial hydraulics: Scour criteria and problems: regimes of flow, Shields curve, incipient motion of sediment particles, terminal fall velocity of sediment in fluid, alluvial bed forms and Resistance to flow.

Sediment transport: Bed load, suspended load and total load transport, Meyer-Peter approach, du Boys' approach, Einstein's approach, Engelund and Fredsøe's approach, sediment samplers, design of stable channels, alluvial stream and their hydraulic geometry.

Turbulent Fluvial Flows: Decomposition and averaging procedure, equation of motion (Reynolds equations), Prandtl's mixing length theory, hypothesis of von Kármán, velocity distribution, the linear law in viscous sub-layer, the logarithmic law in turbulent wall shear layer, law in buffer layer, log-wake law and velocity defect law, turbulence intensity, calculation of bed shear stress using bed slope, velocity distribution, average velocity, Reynolds shear stress distribution, turbulent kinetic energy distribution.

River Training Works: Objectives, classification of river training works, design of guide banks, groynes or spurs their design and classification ISI Recommendations of approach embankments and afflux embankments, pitched islands, artificial cut-offs, objects and design considerations, river control-objectives and methods.

Sediment control: Silt management, management of canal in Punjab, Bhakra calal, delta formation.

Text and Reference Books:

Dey, Subhasish, "Fluvial Hydrodynamics" 2014, Springer, India

Garde, R.J., Raju, K.G.R, "Mechanics of Sediment Transportation and Alluvial Stream Problems" 1985, Wiley Eastern Ltd.

Yang, C.T., "Sediment Transport: Theory and Practice." 1996, McGraw-Hill, USA.

Yalin, M.S., "Mechanics of Sediment Transport" 1977, Pergamon Press, Oxford.

Course Outcomes:

- Students should be able to evaluate the quantity of sediment transport in alluvial channels
- Students should be able to analyse the flow structure on deformable boundaries
- Students should be able to take initiative to protect the rivers by erosion and deposition

CE 557 Water Resources Systems (3-0-0)

Course Objectives:

- To understand the complex water resources processes
- To get familiar optimization techniques and algorithm in reservoir operation
- To analyse the economics and social impact of water resources projects

Course Syllabus:

Basic concepts of systems, need for systems approach in water resources, system design techniques, problem formulation; optimization techniques, LP, NLP, dynamic programming, genetic algorithm, sensitivity analysis, capacity expansion; reservoir operation problems, simulation, case studies; planning, role of a planner, National water policies, public involvement, social impact, economic analysis.

Text and Reference Books:

1. Loucks, D.P., Stedinger, P.J.R., Haith, D.A., Water Resources Systems Planning and Management, Prentice Hall, New Jersy, 1987.

2. Hall, K., A and Draoup, J.A., Water Resources Systems Engineering, Tata McGraw Hill, 1970.

3. Neil, G.S., Water Resources Planning, McGraw Hill, 1985.

4. National Water Policy, Ministry of Water Resources, Government of India, 1987.

Course Outcomes:

- Students should be able to understand the water resources system and its management
- Students should be able to evaluate the quantity of water in various resources of water
- Students should be able to optimize the use of water for different purposes
- Students should be able to carry out the sensitivity, economic and social impact analysis of water projects.

CE 558 Geotechnical Investigations And Ground Improvement (3-0-0)

Course Objectives:

- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

Course Syllabus:

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic

refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions.
Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties.
Report writing. Safety measures.
Geotechnical Processes:
Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control.
Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.
Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis,
lime column. soil-lime column. Grouting : permeation, compaction and jet. Vibrofloatation, dynamic compaction, thermal, freezing. Dewatering systems

Course Outcomes:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization
- Students will learn about geosynthetics and their properties
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Text and Reference Books:

1. Peck, R. B., Hanson, W. B. and Thornburn, T. H., 1974. Foundation Engineering. John Wiley and Sons Inc, New York.
2. Teng, W. C. 1977. Foundation Design. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Schnaid, F., 2009. In Situ Testing in Geomechanics. Taylor and Francis.
3. Bowles, J. E., 1982. Foundation Analysis and Design. McGraw Hill, New York.
4. Coduto, D. P., 2001. Foundation Design. Pearson Education International, New Jersey.

CE 559 Earth Dams And Stability of Slopes (3-0-0)

Course Objectives:

Have an understanding of seismic design concepts and current practices for earth dams and other similar structures to enable them to plan and direct the construction activity appropriately.

Understand the soil dynamic testing procedure and methodology of seismic design to be able to execute a proper design.
Have a clear understanding of design methodology and the interpretation in the seismic codes.

Course Syllabus:

Earth and Rockfill Dams: Selection Criteria, Classification, Causes of failure, Instrumentation, Stress Measurements
Nature and Importance of failure, Piping through embankment, design of filters, Types of failure, Rockfill dams

Course Outcomes:

At the end of the course, the student will be able to:
Describe the behaviour of natural and engineered soil / rock slopes under various weather and engineering conditions.
Explain the factors that may affect the stability of slopes.
Select an appropriate slope stability analysis method subject to geometry of slope, material properties, and uncertainty of observations.
Assess the potential landslide risk of slopes.

Text and Reference Books:

1. Hoek, E. and Bray, J.W., 1981. Rock Slope Engineering. Institution of Mining Engineering
2. Giani, G.P.,1992. Rock Slope Stability Analysis. A A Balkema
3. Wyllie, D. C. and Christofer, W. M., 2004. Rock Slope Engineering. Taylor and Francis.
4. Singh, B. and Goel, R.K., 2002. Software for Engineering Control of Landslides and Tunneling Hazards. A A Balkema.
5. Harr, M.E., 1962. Ground Water and Seepage. McGraw Hill.
6. Chowdhary, R. and Chowdhary, I., 2009. Geotechnical Slope Analysis. CRC Press.

CE 560 Emerging Topics In Geotechnical Engineering (3-0-0)

Course Objectives:

- To provide the idea of old and new techniques, new machinery and construction equipments
- To discuss about different trends in laboratory testing, soil behaviour, construction techniques

Course Syllabus:

A course which will vary from year to year to study new and exicting developments in the broad spectrum of Geotechnical and Geoenvironmental Engineering. The course will also focus on new offshoots of Geotechnical and Geoenvironmental Engineering.
Trends in Site investigation, laboratory testing, design and analysis, ground improvement, underground structures, soil behaviour, construction techniques

Course Outcomes:

- Students should be able to decide on the techniques, machinery and equipments which will be economical as well as beneficial to carry out the required tasks

Text and Reference Books:

1. Mitchell, J. K., 1993. Fundamentals of soil Behaviour. Edition, John Wiley and sons, New York
2. Das, B.M., 1997. Advanced soil Mechanics. Taylor and Francis.
3. Lambe, T.W. and Whitman, R.V., 1987. Soil Mechanics. John Wiley and Sons
4. Gulhati, S. K. and Datta M. 2008. Geotechnical Engineering. Tata Mcgraw-Hill Company Ltd.
5. Coduto, D. P. 2002. Geotechnical Engineering, Principles and Practices. Pearson Education International, New Jersey.
6. Shukla, S. K. and Yin, J. H., 2006. Fundamentals of Geosynthetics Engineering. Taylor and Francis.
7. Schnaid, F., 2009. In Situ Testing in Geomechanics. Taylor and Francis.

Along with the books, reference to different journals, conferences, workshop notes, magazones to be referred which highlight the new trends in geotechnical engineering

CE 566 Pavement Geotechnics and Material

Course Objectives

1. To study the significance of soil subgrade along with its functions, desirable properties of soil as a highway material, soil classification for highway engineering purpose as per different classification system and evaluation of properties.
2. To understand the concept of the mechanics of stresses in soils and characterization of the important properties of the soil to be used in the design.
3. To know the functions of sub-base, base and surface courses of the pavement and understand the geotechnical properties and behaviour of the different geomaterials including stabilized geomaterials, bituminous materials.
4. To know the various ground improvement techniques in the highway construction.
5. To know the significance of the highway / storm water drainage in the network of highway in rural and urban area including hilly region.

Course Syllabus

Subgrade: Functions, importance of subgrade soil properties, subgrade soil classification for highway engineering purpose, evaluation of properties, compaction system.

Stresses in soils: Theories and elastic and plastic behaviour of soils, methods of reducing settlement, estimation of rate of settlement due to consolidation; foundation of road embankment, static and cyclic triaxial test on subgrade soils. Resilient deformation, resilient strain, resilient modulus, CBR test, effect of lateral confinement on CBR and E value of subgrade soil; static and cyclic plate bearing test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture contents, etc.

Material characterization: Functions, geotechnical properties of geomaterials (soils, rocks, soil and rock mixtures, and recycled and alternative materials) for rational and sustainable design and construction, behavior of compacted geomaterials, behavior of stabilized geomaterials (mixtures of soils with - cement, lime, fly ash, polymers and other kind of geomaterials), compaction technology, compaction management, maintenance technology;

Aggregates: Different types, desirable properties, various tests for evaluation of these properties, recommended values as per specification.

Bituminous Materials: Different grades, types of bituminous surfaces, desirable properties and tests for evaluating these properties, Marshall's stability test, bituminous mix design.

Ground Improvement Techniques: Different methods of soil stabilization, use of geosynthetics and fibers, etc. in the highway subgrade and highway construction, other ground improvement techniques (sand drains, band drains, stone columns, gabions, etc.) in the context of highway construction, reinforced earth.

Highway Drainage: General principles, significance, different drainage systems (surface/ sub-surface), drainage systems in the hilly areas, pumping systems, water body, holding ponds, frost action, frost susceptible soils, depth of frost penetration, loss of strength during frost melting, etc., design of drainage systems.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the soil classification in accordance with various prevailing classification system and evaluate the ability of the soil as a subgrade material.

2. Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
3. Understand the characterization of different paving materials along with the tests to be conducted on these materials.
4. Understand the basic deficiencies in the soils to be used as a highway materials and various ways and means of improving the soil and implementing the techniques of ground improvement.
5. Understand the implications of appropriate drainage system for the appropriate performance of the roads, various drainage systems in rural, urban and hilly regions and design the drainage system.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Srinivasakumar, R., 2013. A Text Book of Highway Engineering; University Press, Hyderabad
4. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
5. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
6. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
7. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
8. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
9. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.
10. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.

11. Chakraborty, P. and Das, A., 2013. , Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

10 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

11. Yoder E.J. and Witzack M.W. ,1991. Principles of Pavement Design; John Wiley and Sons, New York.
12. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi
13. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
14. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
15. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.

IRC: 58-2011. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.

IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi

IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

CE 567 Rock Mechanics (3-0-0)

Course Objectives:

- To impart to students the knowledge of the basic mechanics which governs the behaviour of rocks and rock masses so that they can understand the mechanics of structures constructed in/on them.

Course Syllabus:

Definition, Application of Rock Mechanics, Stress and Strain in Rock, Physico - mechanical Properties of Rock, Dynamic Properties of Rock and Rockmass, Time Dependent Properties of Rock, Behaviour of Rockmass, Failure Criteria for Rock and Rockmass, Pre-mining State of Stress

Course Outcomes:

- Students will be able to distinguish between different rocks, kind of failure in rocks, different types of tests in rocks and the bearing capacity of rocks

Text and Reference Books:

1. Hudson, J.A. and Harrison, J. P., 2000. Engineering Rock Mechanics- An Introduction to the Principles. Elsevier
2. Jaeger, J.C. and Cook, N.G.W., 1979. Fundamentals of Rock Mechanics. Mathew & Co. Ltd.
3. Singh, B. and Goel, R.K., 2006. Rock Mass Classification- A Practical Engineering Approach. Elsevier.
4. Hoek, E., 2000. Practical Rock Engineering. Rock Science.
5. Ramamurthy, T., 2008. Engineering in Rocks. PHI Learning Pvt. Ltd.

CE 568 Engineering Geology (3-0-0)

Course Objectives

- Awareness about earth resources and processes to be considered in various facets of civil engineering

- Appreciation of surface of earth as the fundamental foundation structure and the natural phenomena that influence its stability

Course Syllabus:

Relevance of geology in Civil Engineering. Subdivisions of Geology. Interior of the earth. Weathering, its engineering significance and laboratory tests used in civil engineering. Soil profile. Hydrogeology-occurrence of groundwater, Types of aquifers and their properties. Engineering significance of subsurface water in construction. Methods to control of subsurface water. Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of common rock forming minerals Earth quakes- in relation to internal structure of earth and plate tectonics Types of rocks. Brief account of selected rocks. Rock features that influence the strength of rocks as construction material. Rock types of Kerala. Engineering properties of rocks. Attitude of geological structures- strike and dip. Deformation structures and their engineering significance. Geological factors considered in the construction of engineering structures. Introduction to natural hazards and their management. Coastal Processes and protection strategies. Soil erosion and conservation measures.

Course Outcomes:

- The course would help the student to understand of the factors that determine the stability of earth's surface
- The student would comprehend better the earth resources used as building materials

Text and Reference Books:

1. Duggal, S.K., Rawal, N. and Pandey, H.K., 2014. Engineering Geology, McGraw Hill Education, New Delhi.

2. Garg, S.K., 2012. Introduction to Physical and Engineering Geology, Khanna Publishers, New Delhi.

3. Gokhale, K.V.G.K., 2010. Principles of Engineering Geology, BS Publications, Hyderabad 4. Kanithi, V., 2012. Engineering Geology, Universities Press (India) Ltd., Hyderabad

5. Singh, P., 2004. Engineering and General Geology, S. K. Kataria and Sons, New Delhi

6. Bennison, G.M., Olver, P.A. and Moseley, K.A., 2013. An introduction to geological structures and maps, Routledge, London

7. Gokhale, N.W., 1987. Manual of geological maps, CBS Publishers, New Delhi

CE 569 Environmental Impact Assessment

Course Objectives

- To expose the students with the methods of qualitative and quantitative assessment of environmental impacts due to developmental activities.

- To make the students learn planning for mitigation of adverse impact on environment.
- To expose students to the analysis of case studies on environmental impact assessment

Course Content

The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA. List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. Identifying the Key Issues.

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.

Review of Environmental Management Plan and Monitoring. Case Studies.

Course outcome

The student will be able to:

- To review the key concepts of environmental impact assessment and the current legislation covering it
- To prediction and assess the impact from an activity /project on land, water, air, flora and fauna

Text and Reference Books:

1. Sadler, B. and McCabe, M., 2002. Environmental Impact Assessment: Training Resource Manual. UNEP.
2. Rau J. G. and Wooten D. C., 1980. Environmental Impact Analysis Handbook, Tata McGraw-Hill.

3. MOEF, India, EIA manual. Ministry of Environment and Forests, Government of India (http://www.envfor.nic.in/legis/eia/so195.pdf).

4. Canter, R. L., Environmental Impact Assessment, Tata McGraw-Hill (1981).

CE 570 Environmental System Analysis

Course Objectives

- To expose students to a systems approach based mathematical framework for addressing environmental problems.
- To train students in defining systems and their boundaries, apply appropriate algorithms and optimize systems for a set of constraints and objectives.

Course Content

Introduction to natural and man-made systems. Systems modeling as applied to environmental systems. Nature of environmental systems, the model building process addressing to specific environmental problems. Strategies for analyzing and using environmental systems models. Fate and transport models for contaminants in air, water, and soil. Optimization methods (search techniques, linear programming, non-linear programming, dynamic programming) to evaluate alternatives for solid-waste management and water and air pollution control. Optimization over time. Integrated environmental management strategies addressing multi-objective and multi-stakeholder planning.

Course outcomes

The student will be able to:

- To describe and use different environmental system analysis tools.
- To assess strengths and weaknesses for different tools
- To present and critically discuss the results from an environmental system analysis perspective.

Text and Reference Books:

1. Sven E. Jorgensen, 1999. A Systems Approach to the Environmental Analysis of Pollution Minimization. CRC Press.
2. Tanimoto, Jun. 2014. Mathematical Analysis of Environmental System. Springer, 2014
3. Haith, D. A., 1982. Environmental Systems Optimization. John Wiley & Sons, New York, NY.

CE 571 Risk and Reliability in Geotechnical Engineering (3-0-0)

Course Objectives:

- To introduce graduate students the concepts and application of risk and reliability
- To be able to compute first- and second-order estimates of failure probabilities of engineered systems
- To be able to update reliability estimates based on new observational data
- To be able to identify the relative advantages and disadvantages of various analytical reliability methods, as well as Monte Carlo simulation

Course Syllabus:

Introduction: Sources and types of uncertainties associated with geotechnical analysis, importance of probabilistic methods and reliability based analysis in geotechnical engineering Review of probability and statistics: Discrete and continuous random variables, parameter estimation, testing of hypothesis, regression analysis Fundamentals of reliability analysis: First Order Second Moment (FOSM) method, First Order Reliability Method (FORM), Second Order Reliability Method (SORM), Monte Carlo simulation Application towards geotechnical problems: Characterization of uncertainty in field measured and laboratory measured soil properties, uncertainty in interpretation techniques Spatial variability of soil properties, scale of fluctuations, estimation of auto correlation and auto covariance Probabilistic groundwater modeling, flow through earth dams Probabilistic slope stability analysis Fundamentals of LRFD design methodology, reliability based design of shallow and deep foundations, settlement analysis Reliability based liquefaction analysis, lateral spreading Development of fragility curves for geotechnical problems

Course Outcomes:

- Students will be able to compute first- and second-order estimates of failure probabilities of engineered systems
- Students will be able to measure the relative importance of the random variables associated with a system;
- Students will be able to update reliability estimates based on new observational data
- Students will be able to identify the relative advantages and disadvantages of various analytical reliability methods, as well as Monte Carlo simulation

Text and Reference Books:

1. Phoon, K. and Ching, J., 2015. Risk and Reliability in Geotechnical Engineering. Taylor and Francis, New York.
2. Baecher, G.B. and Christian, J.T., 2003. Reliability and Statistics in Geotechnical Engineering. John Wiley and Sons, Sussex, England
3. Modarres, M., Kaminskiy, M. and Krivtsov, V. 1999. Reliability Engineering and Risk Analysis - A Practical Guide. Marcel Dekker Inc, Basel, New York.
4. Halder, A. and Mahadevan, S., 2000. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley.
5. Ang, A.H.S. and Tang, W. H., 1975. Probability Concepts in Engineering Planning and Design. Wiley.

CE 572 Constitutive Models for Soil (3-0-0)

Course Objectives:

- To introduce fundamentals of constitutive modelling of soils
- Students will learn elastic, viscoelastic, plastic, viscoplastic material responses and continuum damage mechanics
- Students will learn how microstructural mechanisms influence the macroscopic mechanical behavior in different materials

Course Syllabus:

Stress strain relationships. Definition of stress and strain tensors. Elasticity. Linear Elasticity. Generalized Hooke's law. Field equations in linear elasticity.

Linear elasticity and incrementally non-linear elastic formulation. Stress-strain relationships, strength and volumetric response. Evaluation of model parameters. Incremental finite element analyses.

Plasticity theory. Incrementally linearized elasto-plastic formulation. Linear elastic-perfectly plastic. Critical state soil mechanics framework (Cam-clay and modified cam-clay models). Drained and undrained response of clays. Effects of consolidation stress history.

Compressibility of soils. Yielding for soils. Stress and strain history. Plastic hardening. Evolving anisotropy. Small strain non-linear "elastic" response. Hysteretic response. Large strain failure criteria: Von Mises, Drucker-Prager, Mohr Coulomb.

Course Outcomes:

- Students will learn the fundamentals of constitutive models
- Students will learn various kinds of elastic and inelastic, e.g, plastic, viscoplastic, viscoelastic, material response
- Students should be able to develop constitutive models

Text and Reference Books:

1. Desai, C.S., 2000. Mechanics of Materials and Interfaces:The Disturbed State Concept. CRC Press LLC.
2. Desai, C.S. and Siriwardane, H. J., 1984. Constitutive Laws for Engineering Materials with Emphasis on Geologic Materials. Prentice-Hall, Inc., New Jersey.
3. Hicher and Shao, 2008. Constitutive Modeling of Soils and Rocks. John Wiley
4. Potts, D. M. and Zdravkovic, L., 1999. Finite Element Analysis in Geotechnical Engineering Theory. Thomas Telford.
5. Selvadurai, A.P.S. and Boulon, M. J., 1995. Mechanics of Geomaterial Interfaces, Elsevier.

CE 573 Natural treatment Systems (3-0-0)

Course Objectives

- To provide knowledge regarding natural wastewater treating technologies
- To provide know-how for designing a low cost and sustainable wastewater treatment system

Course Content

Introduction: Natural wastewater treatment Systems (NWTS), Main Types Of NWTS, Advantages And Disadvantages Of NWTS, Flows And Loads, Preliminary Treatment.

Septic tanks, Waste stabilization ponds - Facultative Ponds, Maturation Ponds, Polishing Ponds, Physical Design, Sampling And Performance Evaluation, Operation And Maintenance, WSP Design Example, Case Study. Rock filters: Types Of Rock Filter, Un-aerated Rock filter for BOD And SS Removal, Aerated Rock filter for Ammonia Removal.

Constructed wetlands: Types Of Constructed Wetlands, Free-Water-Surface CW, Subsurface Horizontal-Flow CW, Vertical-Flow CW, Physical Design, Operation and Maintenance, Compact Vertical Flow-CW Treating Raw Wastewater, Nitrification, Denitrification, Phosphorous removal, heavy metal removal, CW Design Examples.

Application of Constructed wetlands for urban floods: Case studies and design examples.

NWTS technology selection: Comparative Costs, Technology Selection.

Course outcomes

The student will be able to:

- Design a low cost, sustainable wastewater treatment system.
- Practically implement NTS systems for field applications
- Appreciate wider applications of natural treatment systems

Text and Reference Books:

1. Kadlec, R.H., Wallace, S., 2008. Treatment Wetlands, CRC Press.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.
3. Garg, S.K., Environmental Engineering (Vol. II), Khanna Publishers, Delhi.

4. Metcalf and Eddy, 2017. Wastewater Engineering: Treatment and Reuse, McGraw Hill Education.
5. IWA, 2017. Treatment Wetlands. IWA Publishing. https://doi.org/10.2166/9781780408774

CE 541 Pavement Analysis and Design (3-0-0)

Course Objectives

1. To study the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations.
4. To introduce the constructions of different types of highway pavements.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Course Syllabus

Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories , ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.

Flexible Pavement Design: Various approaches for designing the highway and airport pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements (highways and airports) and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods, design of joints

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement consruction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc.

Evaluation and Strengthening:

Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, overview of the revision of specifications pertaining to these methods, design of different overlays, skid resistance and measurement

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of low volume roads.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;

5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
4. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
5. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
6. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
7. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
8. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.
9. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.
10. Chakraborty, P. and Das, A., 2013. Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

11 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

16. Yoder E.J. and Witzack M.W., 1991. Principles of Pavement Design; John Wiley and Sons, New York.
17. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi

18. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
19. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
20. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. "Tentative Guidelines for the Design of Flexible Pavements," Indian Road Congress, Delhi.

IRC: 58-2015. "Tentative Guidelines for the Design of Rigid Pavements," Indian Road Congress, Delhi.

IRC: 81-2012. "Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique," Indian Road Congress, Delhi

IRC: SP: 76-2008. "Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping," Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

CE 574 Watershed Management and Remote Sensing Applications (3-0-0)

Course Objectives:

- To understand the catchment management system
- To get familiar with remote sensing and their link with surface properties
- To identify the satellite and their use in Civil Engineering Profession

Principles of watershed management, soil water conservation practices, integrated planning, multi-disciplinary approach, management of agricultural lands - structural and non-structural measures, forest and grass land management, erosion problems and controlling techniques, gully control, landslide and correction techniques, soil water plant relationships, watershed modeling.

Remote sensing: fundamentals – physics of remote sensing – electromagnetic radiation,interaction of ENR with atmosphere, earth surface, soils, water and vegetation. Data acquisition, photographic system and imaging systems, single vertical photographs, visible and near infrared imagery, photo interpretation, visual analysis, spectral properties of water, photogrammetry, stereoscopic viewing, application to water resources mapping, area assessment and watershed management – satellite data – geo-coding – GPS and GIS utilities – classification using imageries – applications in water resources and watershed management – case studies.

Text and Reference Books:

1. Lillesand, K., Remote Sensing and Image Interpretation, John Wiley & Sons, 1979.

2. Tideman, E.M., Watershed Management – Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi, 1996.

3. FAO Watershed management and Field manual, 13/1, 13/2,13/3,13/4,13/5 FAO, UN, Rome, 1988.

4. Reeves, R.G., Manual of Remote Sensing, Volume I and II, American Society of Photogrammetr, Falls Church, 1975.

Course Outcomes:

1. Introduction to basis of GIS and watershed management includes conservation soil.
2. Understand the mapping process and geographical coordinate system of earth.
3. Able to do vector based and raster based data processing.
4. Knowledge of remote sensing and its components.
5. To apply integration of remote sensing and GIS.

LABORATORY

CE 561 Materials Testing And Characterization Laboratory (0-0-3)

Course Objectives

- The objective is to characterize the geosynthetics and waste materials used in construction industry

List of Experiments

- Specific gravity of available waste material
- Shear tests of waste material and geosynthetics, stress paths
- Hydrometer analysis of waste materials

Course Outcomes

- Students should be able to perform the various tests on geosynthetics as well as waste materials

CE 562 Soil Engineering Laboratory (0-0-3)

Course Objectives:

- The objective is to learn to perform basic tests on soil and determine the properties of various soils

List of Experiments

- Determination of relative density
- Vane shear test
- Consolidation tests
- Direct shear and tri-axial compression test – UU, CU, CD tests ,Influence of strain rate, Stress path testing etc.
- Standard penetration tests 5. Dynamic cone penetration tests
- Plate load tests
- Hydrometer Test

Course Outcomes

- Students should be able to perform different tests on soils

|CE 563 Advanced Water and Wastewater Laboratory (0-0-3)

Course Objectives

- To enable the students in analysing the physical and chemical characteristics of water and wastewater
- To familiarize the students with the methods to estimate the organic strength of wastewater

Course Content

Principles of instrumentation and application for water quality parameters measurements.
Indicative list of experiments:
Physical and Chemical Characteristics of Water - pH, Electrical Conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates; Estimation of Solids (TSS, TDS, VSS, FSS); Estimation of Nitrogen (Ammonical Nitrogen, Nitrite, Nitrate, TKN); Estimation of Phosphates and Sulphates; Determination of heavy metals using AAS; Determination of COD using spectrophotometer; Ambient Air Quality Analysis - Determination of SPM, CO, NO_X and $SO_{X;}$ Soil Analysis - pH, Conductivity, Cation Exchange Capacity, Sodium Adsorption Ratio.

Course Outcomes

Students will be able to

- To conduct experiments as per standard methods of sampling and analysis.
- To demonstrate the expertise to characterize water and wastewater samples.
- To understand the importance of laboratory analysis as a controlling factor in the treatment of water and wastewater**.**

Text and Reference Books:

1. Sawyer,C.N., McCarty, P.L. and Parkin,G.F., (2002). Chemistry for Environmental Engineering and Science. 5th edition, McGraw-Hill Publishing Company.
2. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2012.

CE 564 Simulation Laboratory (0-0-3)

Course Objectives

- To be able to write a computer code for different numerical methods

List of Experiments

- Introductory exercises on MATLAB and other software
- Simulation using MATLAB – an exercise on a simulation method
- Development of algorithms/codes by considering different methods for: roots of equations
- Solution of simultaneous equation (linear-nonlinear),
- Eigen value and Eigen vectors
- Numerical integration
- Solution of differential equation

Course Outcomes

- Students should be able to write basic codes for different numerical methods and apply the codes for problems in geotechnical engineering

CE 590 Modelling and Research Methodology

Course Objectives

1. Learn the research types, methodology and formulation.
2. Know the sources of literature, survey, review and quality journals.
3. Understand the research design for collection of research data.
4. Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes

1. Differentiate the research types and methodology.
2. Able to do literature survey using quality journals.
3. Able to collect research data.
4. Process research data to write research report for grant proposal.

Course Syllabus

UNIT –I Research methodology

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

UNIT –II Literature survey

Importance of literature survey -Sources of information -Assessment of quality of journals and articles -Information through internet. Literature review: Need of review -Guidelines for review - Record of research review.

UNIT –III Research design

Meaning of research design -Need of research design -Feature of a good design -Important concepts related to research design -Different research designs -Basic principles of experimental design -Developing a research plan -Design of experimental set-up -Use of standards and codes of Civil Engineering.

UNIT –IV Data collection and analysis:

Collection of primary data and Secondary data of different Civil Engineering fields -Data organization -Methods of data grouping -Diagrammatic representation of data -Graphic representation of data -Sample design -Need for sampling -Some important sampling definitions -Estimation of population -Role of statistics for data analysis -Parametric vs. non parametric methods -Descriptive statistics -Measures of central tendency and dispersion -Hypothesis testing -Use of statistical softwares. Data Analysis: Deterministic and random data -Uncertainty analysis

-Tests for significance -Chi-square -Student's t-test -Regression modeling -Direct and interaction effects –ANOVA-F-test -Time series analysis -Autocorrelation and autoregressive modeling.

UNIT –V Research report writing: Format of the research report –Synopsis –Dissertation -Thesis -Its differentiation –References –Bibliography -Technical paper writing -Journal report writing - Making presentation -Use of visual aids. Research proposal preparation: Writing a research proposal and research report -Writing research grant proposal.

Text and Reference Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. 2002. An introduction to research methodology, RBSA Publishers.
2. Kothari, C.R, 2004. Research methodology, methods & technique, New Age International Publishers, New Delhi.
3. Ganesan, R. 2015. Research methodology for engineers, MJP Publishers, Chennai.
4. Khananabis, Ratan and Saha, Suvasis 2015. Research methodology, Universities Press, Hyderabad.
5. Agarwal,Y.P. 2004. Statistical Methods: concepts, application and computation, Sterling Publishing Pvt. Ltd., New Delhi.
6. Upagade, Vijay and Shende, Aravind 2009. Research methodology, S. Chand & Company Ltd., New Delhi.
7. Nageswara Rao, G. 2012. Research methodology and quantitative methods, BS Publications, Hyderabad.

Teaching scheme and syllabus for PG Diploma in Civil Engineering: Structural & Construction Engineering specialization

Enclosure #5(a)

CURRICULUM

PG Diploma in Civil Engineering

with specialization in
(STRUCTURAL AND CONSTRUCTION ENGINEERING)

(July 2019 admission onwards)

APPROVED BY

BOARD OF STUDIES (BOS)

12th MEETING, February 20, 2019

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

TEACHING SCHEME

Semester – I

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - I	3	0	0	3
CE	Course - II	3	0	0	3
CE	Course - III	3	0	0	3
CE	Course - IV	3	0	0	3
CE	Course - V	3	0	0	3
CE	Lab-I	0	0	3	2
CE	Lab-II	0	0	3	2
Total					19

Semester - II

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - VI	3	0	0	3
CE	Course - VII	3	0	0	3
CE	Course - VIII	3	0	0	3
CE	Course - IX	3	0	0	3
CE	Course - X	3	0	0	3
CE	Lab-III	0	0	3	2
CE	Lab-IV	0	0	3	2
Total					19

Note: 6 Core theory courses, 4 elective courses and 4 laboratories (or industrial projects, where 1 industrial project is equivalent to 2 laboratory courses) need to be completed for the degree.

Grand Total of Credits = 38

LIST OF CORE COURSES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-501	Advanced Solid Mechanics	3	0	0	3
2.	CE-502	Advanced Reinforced Concrete Design	3	0	0	3
3.	CE-503	Structural Dynamics	3	0	0	3
4.	CE-504	Analysis and Design of Foundations	3	0	0	3
5.	CE-505	Finite Elements Analysis	3	0	0	3
6.	CE-506	Earthquake Resistant Design of Structures	3	0	0	3
7.	CE-507	Advanced Structural Analysis	3	0	0	3
8.	CE-508	Advanced Construction Practices	3	0	0	3
9.	CE-509	Quantitative Methods in Construction Management	3	0	0	3
10.	CE-601	Independent Study	0	0	6	3
11.	CE-600	Dissertation Part-I Dissertation Part-II	0	0	30	6+12

LIST OF LABORATORY COURSES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-520	Foundation Engineering Laboratory	0	0	3	2
2.	CE-521	CAD Laboratory	0	0	3	2
3.	CE-522	Concrete Structures Laboratory	0	0	3	2
4.	CE-523	Material Testing Laboratory	0	0	3	2

LIST OF ELECTIVES FOR M. TECH.

(STRUCTURAL AND CONSTRUCTION ENGINEERING)

S. No.	Course No.	Course Title	Periods			Credits
			L	T	P/D	
1.	CE-510	Quality and Safety Management in Construction	3	0	0	3
2.	CE-511	Construction Economics and Finance	3	0	0	3
3.	CE-512	Repair and Retrofitting of Structures	3	0	0	3

4.	CE-513	Advanced Numerical Methods	3	0	0	3
5.	CE-514	Highway Construction and Maintenance	3	0	0	3
6.	CE-515	Theory of plates And Shells	3	0	0	3
7.	CE-516	Geospatial Technologies	3	0	0	3
8.	CE-517	Pre-stressed Concrete Design	3	0	0	3
9.	CE-518	Infrastructures Development Projects	3	0	0	3
10.	CE-519	Analysis and Design of Tall Buildings	3	0	0	3
11.	CE-526	Construction Methods and Equipment	3	0	0	3
12.	CE-527	Design of Industrial Structures	3	0	0	3
13.	CE- 528	Advanced Steel Design	3	0	0	3
14.	CE- 529	Soil Dynamics and Machine Foundations	3	0	0	3
15.	CE-530	Construction and Contract Management	3	0	0	3
16.	CE-531	Geoenvironmental Engineering	3	0	0	3
17.	CE-532	Landfill and Ash ponds	3	0	0	3
18.	CE-533	Solid and Hazardous Waste Management	3	0	0	3
19.	CE-534	Concrete Mechanics	3	0	0	3
20.	CE-535	Recent Advances in Construction Materials	3	0	0	3
21.	CE-536	Composite Materials	3	0	0	3
22.	CE-537	Simulation & Modelling	3	0	0	3
23.	CE-538	Site Investigations and Ground Improvement	3	0	0	3
24.	CE-539	Engineering Behaviour of Soils	3	0	0	3
25.	CE-540	Geosynthetics	3	0	0	3
26.	CE-541	Pavement Analysis, Design and Construction	3	0	0	3
26.	ID-601	Research Methodology	3	0	0	3
27.	CE-590	Modelling and Research methodology	3	0	0	3

CE 501 Advanced Solid Mechanics [3-0-0-3]

Course Objectives

- To understand solving Methods of three-dimensional stress and strain analysis and extended to allow the student and to obtain solutions using analytical as well as numerical methods.
- This subject will include the analyses of principal stresses and strains, state of stress and strain, true stress-true strain and generalized Hooke's law and failure criteria.
- In addition, this subject will focus on plastic deformation of solids, including the analysis of residual stresses and the collapse load of structures subjected temperature and mechanical loading.
- To understand the responses of materials to fatigue and fracture, as well as their creep and viscoelastic behavior.

Course Syllabus

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

Course Outcomes

- This subject helps to understand the theory of elasticity including strain/displacement and Hooke's law relationships;
- As outcome, subject helps to analyze solid mechanics problems using classical methods and energy methods;
- To solve for stresses and deflections of beams under unsymmetrical loading;
- To locate the shear center of thin wall beams; and to obtain stresses and deflections of beams on elastic foundations;

- To obtain solutions to column buckling and plate problems; as well as to apply various failure criteria for general stress states at points.

Text and Reference Books:

1. Timoshenko S P and Goodier J N "Theory of Elasticity" McGraw Hill, New York,2002.
2. Housner G W and Vreeland J R "The Analysis of Stress and Deformation" Mcmillan London, 1998.
3. Srinath L S "Advanced Mechanics of Solids" Tata Mcgraw Hill, New Delhi, 2000.
4. Westergaard H M "Theory of Elasticity and Plasticity" Harvard University Press, Cambridge, 1998.
5. Kazimi S M A "Solid Mechanics" Tata McGraw Hill, New Delhi, 1999.

CE-502 Advanced Reinforced Concrete Design [3 0 0 3]

Course Objective:

- To make students Understandable about the various elements of different types of industrial and non-industrial RCC structures.
- To make students' Knowledgeable of design provisions given in Indian standard code.
- To make students able to design the basic elements like, beams, slab.
- To make students able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

Course Syllabus:

Deflections of Reinforced Concrete Beams and Slabs; Estimation of Crack Widths in Reinforced Concrete Beams; Inelastic Analysis of Reinforced Concrete Beams and Frames; Design of Shear Walls, Cast-in-Situ Beam-Column Joints, Deep Beams, Chimneys, Ribbed Slabs; Design of Reinforced Concrete Members for Fire Resistance; Software Applications, Virendeel Girders, Concrete Trusses.

Course Outcome:

- Understand the various elements of different types of industrial and non-industrial RCC structures.
- Knowledge of design provisions given in Indian standard code.

- Able to design the basic elements like, beams, slab.
- Able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

Books Recommended:

1. Varghese P C "Advanced Reinforced Concrete Design" Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.
2. Krishna Raju N "Advanced Reinforced Concrete Design" CBS Publishers and Distributors, New Delhi, 1988.
3. Park R and Paulay T "Reinforced Concrete Structures" John Wiley and Sons, New York, 1975.
4. SP 208 "Examples for the Design of Structural Concrete with Strut – and – Tie Models" Editor: Karl – Heinz Reineck, American Concrete Institute, Michigan, 2003.
5. Leet, Kenneth M and Bernal D "Reinforced Concrete Design" McGraw Hill, London, 1998.

CE 503 Structural Dynamics [3-0-0-3]

Course Objective:

- To analyze structures subjected to any kind of dynamic excitation and computing quantities like displacements, forces, stresses, etc.
- Understanding the analytical methods and procedures in a way that emphasize physical insight.
- Ability to apply the structural dynamics theory to real-world problems like seismic analysis and design of structures.
- To study the mode shapes and frequencies of single and multi degree of freedom of structures.

Course Syllabus

Concept of degrees of freedom and constraints, Equations of motion, Newton's Law and De Alembert's Principle, Response of single degree of freedom systems to initial conditions, Response to harmonic excitation, Dynamic amplification factor, Transmissibility, Base Isolation, Response to non harmonic excitations such as impulse, step loading and blast loading, Duhamel's Integral, Earthquake response analysis, Response spectrum, Theory of vibration pick – ups, Estimation of dynamic characteristics through experimental investigations, Multi degree of freedom systems, Orthogonality of mode shapes, Mode superposition method for seismic analysis.

Course Outcome:

- Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
- Create simple computer models for engineering structures using knowledge of structural dynamics interpret dynamic analysis results for design, analysis and research purposes apply structural dynamics theory to earthquake analysis, response, and design of structures

Books Recommended:

1. Clough R W, Penzien J, "Dynamics of Structures", McGraw-Hill, Inc, New York, 1991.
2. Chopra A K "Dynamics of Structures: Theory and Applications to Earthquake Engineering" Prentice Hall (India) Private Ltd, New Delhi, 2000.
3. Roy Creig Jr. "Structural Dynamics: An Introduction to Computer Methods", John Wiley & Sons, New York, 1981.
4. James M L, Smith G M, Wolford J C and Whaley P W "Vibration of Mechanical and Structural Systems : With Microcomputer Applications", Happer & Row, Publishers, New York, 1989.
5. Rao S S, "Mechanical Vibrations", Pearson Education, New Delhi, 2004.

CE-504 Analysis and Design of Foundation Structures [3 0 0 3]

Course Objective:

- To be able to develop deeper understanding of shallow and deep foundations.
- To be able to develop understanding of different design parameters.
- To be able to design foundations and reinforced retaining walls.

Course Syllabus:

Introduction to shallow and deep footings, Design of strap, Raft and combined footings, Design of pile footings, Caps for piles, design of different components of well foundations, Footings subjected to eccentric loading, uplift and overturning, Soil-Structure interaction, Sub grade reaction method, Geotechnical design considerations, Site and soil conditions, Soil liquefaction, Evaluating the liquefaction potential by Standard Penetration Tests, by Cone Penetration Tests, by

Shear Wave Velocity, Liquefaction of clayey soil, Mitigation of Liquefaction Hazard by site modification, Mitigation of Liquefaction Hazard by Structural Design, Seismic Settlement, Subsidence and Differential Compaction, Fault Rupture, Lateral Seismic Earth Pressures.

Course Outcome:

- Students will be able to design shallow and deep foundations.
- Students will be able to determine different design parameters.
- Students will be able to design reinforced retaining wall.

Books Recommended:

1. Saran S "Analysis and Design of Sub-Structures" Oxford and IBH, New Delhi, 1996.
2. Bowls J E "Foundation Analysis and Design" Mc Graw Hill, New York, 1988.
3. Peck R B, Henson W E and Thorn burn W T "Foundation Engineering" John Willey and Sons, New York, 1984.
4. Teng W C "Foundation Design" Prentice Hall, New Delhi, 1992.
5. Naeim F "The Seismic Design Hand Book", Kluwer Academic Publishers, London, 2001.
6. Krammer S "Geotechnical Earthquake Engineering" Pearson Education Pvt. Ltd. New Delhi, 2003.

CE 505 Finite Elements Analysis [3-0-0-3]

Course Objective:

- To implement the basics of FEM to relate stresses and strains.
- To solve one, two and three dimensional and dynamic problems using Finite Element Analysis.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements;
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Syllabus

Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, Some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

Course Outcome:

- Implement numerical methods to solve mechanics of solids problems.
- Formulate and Solve axially loaded bar Problems.
- Formulate and analyze truss and beam problems.
- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
- Formulate and solve Axi-symmetric and heat transfer problems.

Books Recommended:

1. Zienkiewiez O. C., “The Finite Element Method” Mcgraw Hill, London, 1991.
2. Abel J F and Desai C A “Finite Element Method” Van Nostrand Reinhold, New York., 2004.
3. Reddy, J.N., “An Introduction to the Finite Element Method”, Tata McGraw Hill, New Delhi, 2003.
4. Bathe K J “Finite Element Procedures” prentice Hall of India Private Limited, New Delhi, 1997.
5. Chandrupatla T R and belegundu A D “Introduction to Finite Elements in Engineering” Prentice Hall of India Private Limited, New Delhi, 1997.

CE-506 Earthquake Resistant Design of Structures [3 0 0 3]

Course Objective:

- To Study the multimodal and multidirectional response spectrum analysis.
- To make students familiar regarding understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To make students able to do seismic design and detailing of structures with reference to is code.

Course Syllabus:

Behaviour of buildings and structures during past earthquakes and lessons learnt, goals of earthquake resistant design. Linear static procedure for seismic load calculation – IS 1893 – 2002, 2016 combination of gravity and seismic action. Multimodal and Multidirectional response spectrum analysis. Earthquake resistant measures at planning stage: Geotechnical and architectural considerations, irregularities, earthquake resistant measures in sloping roofs, staircase, foundations and general construction details IS : 4326 –1993, principals of earthquake resistant design – behaviour of concrete and steel, confined concrete, the capacity design method; Study of IS 13920 – 1993, 2016 behaviour of masonry structures during earthquakes, analysis and behaviour of masonry infilled RC frames, earthquake resistant measures in masonry buildings.

Course Outcome:

- Study the multimodal and multidirectional response spectrum analysis.
- Understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- Able to do seismic design and detailing of structures with reference to is code.

Books Recommended:

1. Dowrick D J "Earthquake Resistant Design for Engineers and Architects" John Wiley and Sons, New York, 1987.
2. Dowrick D J "Earthquake Risk Reduction" John Wiley and Sons, New York, 2003.
3. Englekirk R E "Seismic Design of Reinforced and Pre-cast Concrete Buildings" John Wiley and Sons, New York, 2003.

4. Pauley T and Priestley M J N "Seismic Design of Reinforced Concrete and Masonry Buildings" John Wiley and Sons, New York, 1992.
5. Key D "Earthquake Design Practices for Buildings" Telford Publishers, London, 1990.

CE-507 Advanced Structural Analysis [3-0-0-3]

Course Objective:

- To make students able to determine the various properties of cement experimentally
- To determine the specific gravity and water absorption of fine and coarse aggregates.
- To perform various test of fresh and harden concrete.
- To make students able to carry out the test procedure of compressive test and flexure test.

Course Syllabus:

Basic concepts, Degree of static and kinematic indeterminacy, Matrix algebra, Solution of simultaneous equations by Gaussian Elimination, Flexibility and Stiffness Matrices, System Approach: Development of stiffness matrix, Applications of stiffness method to continuous beams, trusses and frames. Effect of temperature, and prestrain. Element Approach: Element stiffness, 2D truss element and beam element, Transformation matrix, Assembly of global stiffness matrix, Storage requirement of stiffness matrix i.e. full storage, banded storage and skyline storage, Effect of node and element numbering, Boundary conditions, Application of stiffness method to beams, trusses and frames. Computer applications, Material and geometrical non-linearity, Application of Virtual work and energy principles.

Course Outcome:

- Determination of various properties of cement experimentally.
- Determination of specific gravity and water absorption of fine and coarse aggregates.
- Various test of fresh and harden concrete.
- Carry out the test procedure of compressive test and flexure test.

Books Recommended:

1. Pandit G S and Gupta S P "Matrix Analysis of Structures" Tata McGraw Hill, New Delhi, 2003.
2. Gere W and Weaver J M "Matrix Analysis of Structures" CBS Publishers, New Delhi, 2002.
3. Rajasekaran S and Sankarasubramanian G "Computational Structural Mechanics" Prentice Hall India, New Delhi, 2001.
4. Vazirani V N and Ratwani M M "Advanced Theory OF structures and Matrix Method" Khanna Publishers, New Delhi, 1995.

CE-508 Advanced Construction Practices [3 0 0 3]

Course Objective:

- To give an experience in the implementation of new technology concepts which are applied in field of advanced construction.
- To enable students to describe, analyze, compare and evaluate the technology of mass concreting, industrialised construction and special construction methods.
- To aware the students of some of the problems that can be associated with construction in extreme weathers and difficult conditions.

Course Syllabus:

Concrete Construction Methods, Formwork Design and Scaffolding; Slip Forms and other moving forms; Pumping of Concrete; Grouting and Mass Concreting Operations (roller compacted concrete); Ready-Mix Concrete; Various Methods of Handling and Placing Concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Prestressing. Steel and Composite Construction Methods**,** Fabrication and erection of structures including heavy structures, Prefab construction, Industrialised construction and Modular coordination. Special Construction Methods, Construction in Marine Environments, High Rise Construction, Bridge Construction including Segmental Construction, Incremental Construction and Push Launching Techniques; Geosynthetics; Safety, Quality Measures and Reliability.

Course Outcome:

- Students shall understand the latest construction techniques applied to Engineering Construction.

- Students will attain an overall picture of special construction methods with a good understanding of the onsite construction issues and gain an insight in constructing civil, industrial, bridges and building type projects in extreme conditions.

Books Recommended:

1. Neville A M and Brooks J J “Concrete Technology”,Pearson Education Asia, Singapore, 1994.
2. Neville A M “Properties of Concrete”, Pearson Education, New Delhi, 2004.
3. Peurifoy R L “Construction Planning, Equipment and Methods” McGraw Hill Ltd., New York, 2002.

CE-509 Quantitative Methods in Construction Management [3 0 0 3]

Course Objective:

- Review the basic concepts of probability and statistics.
- To apply linear programming for optimization of various problems.
- To get familiar with queuing theory, decision theory and game theory.
- To get overview of modifications and improvement on CPM/PERT techniques.

Course Syllabus:

Introduction and concepts of probability and statistics, Optimization through Linear programming- Need for linear programming, Linear programming model, dual problem, dynamic programming. Transportation model, solution of Transportation model, Assignment problems, solution of assignment problem. Queuing theory- waiting line models, deterministic model, probabilistic model, Decision theory- decision analysis, decision under uncertainity, Nature of Games, Games model, solution of Games model, simulations as applied to construction-simulation models, steps in simulation, Monte carlo simulation. Modifications and improvement on CPM/PERT techniques.

Course Outcome:

- Students will learn the basics of probability and statistics, linear programming for optimization, queuing theory, game theory and CPM/PERT tecniques.

Books Recommended:

1. Verma M “Construction Planning and Management Through System Techniques” Metropolitan Book Company, New Delhi, 1985.
2. Chitkara K K “Construction Project Management – Planning, Scheduling and Controlling” Tata McGraw Hill, New Delhi, 2000.
3. O’Brien J “CPM in Construction Management” McGraw Hill, New York, 1999.
4. Harris R B “Precedence and Arrow Networking Techniques for Construction” John Wiley & sons, New York, 1999.
5. Levy S “Project Management in Construction” McGraw hill, New York, 2000.

CE-520 Foundation Engineering Laboratory [0 0 3 2]

Course Objective:

- The objective is to learn to perform tests on soil and determine the properties of various soils

Course Syllabus:

Plate load test,
Standard penetration test,
Static cone penetration test,
Dynamic cone penetration test
Triaxial shear test,
Large shear box test and
testing of Geotextiles and geofibres.

Course Outcome:

- Students will be able to perform different tests on soils

CE 521 CAD Laboratory [0-0-3-2]

Course Objective:

- To impart fundamental knowledge to students in the latest technological topics on Computer Aided Design, analysis of building and Computer Aided Engineering Analysis.

- To create congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.
- To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

Course Syllabus:

Introduction to various research and design softwares and their applications

- Comparison of Numerical and theoretical deflection of single and multispan beam with pinned and fixed supports
- Analysis and design of G+4 building against Dead and Live load using STAAD Pro.
- Analysis and design of Multistorey framed building against Earthquake & wind loading using STAAD Pro.
- Analysis and design of steel truss against seismic loading using STAAD Pro.
- Analysis and design of suspension Cable Bridge using STAAD Pro.
- Determine the stress and deformation of one way and two way slab using ABAQUS/CAE.
- Determine the stress and deformation of singly and doubly reinforced concrete beam using ABAQUS/CAE.
- Determine the stress and deformation of axially loaded reinforced concrete column using ABAQUS/CAE.
- Determine the stress and deformation of steel truss bridges using ABAQUS/CAE.

Course Outcome:

- Apply solutions or to do research in the areas of Design and simulation in the field of civil Engineering.
- Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.
- Formulate relevant research problems; conduct analytical study and analyzing results with modern mathematical methods and use of software tools.
- Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.

CE-522 Concrete Structures Laboratory [0-0-3-2]

Course Objective:

- To perform the testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

Course Syllabus:

- Testing of PCC and SFRC samples under compression and flexural testing under static and
- fatigue loading.

Course Outcome:

- Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

CE-523 Material Testing Laboratory [0 0 3 2]

Course Objective:

- To make students aware about the design of concrete mixes for high strength and high performance of fly ash concrete.

Course Syllabus:

- Design of concrete mixes for high strength and high performance of flyash concrete.

Course Outcome:

- Design of concrete mixes for high strength and high performance of fly ash concrete.

CE 601 Independent Study [0-0-6-3]

Course Objective:

- To develop students into self-directed learners and independent researchers.
- To provide more scope and depth in the Graduate Kinesiology curriculum by encouraging students to Investigate areas of interest not currently included in any approved course at NIT Jalandhar.
- To study areas and develop projects that cut across existing course boundaries.
- To understand more deeply into specific parts of an existing course offering.

- To provide the student with sufficient circumstances to assess personal aptitude for the sport management, fitness management, or sports studies field.
- To develop a critical understanding of and the ability to apply theoretical knowledge from the student's chosen concentration, sport management, fitness management, or sports studies, in a research or self-directed learning environment.

Guidelines:

This is a seminar oriented subject in which the student is required to select a topic of his interest related to recent developments and the state-of-the art in the field under study in consultation with a designated faculty advisor. The student shall be required to carry out a comprehensive literature survey on the selected topic and compile a detailed report and present a minimum of two seminars comprising of one mid-term seminar and one end semester seminar. A continuous evaluation of the student performance in terms of seminar presentation and final report shall be carried out.

Course Outcome:

- Students will be required to identify, describe, and document at least three personal learning outcomes specific to their independent study to help ensure their independent study experience is congruent with their personal, professional goals.
- These outcomes must be included on the student's independent study report and approved by their faculty advisor.

CE 600 Dissertation Part-I [0-0-6-6] and Dissertation Part-II [0-0-24-12]

Guidelines:

Candidate should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for Dissertation and finalize/ settle it in consultation with Guide/ Supervisor.

Pursuant to this, the candidate shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.

Candidate should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The learner shall compile the report in standard format.

Candidates are advised to publish in reputed International/National Conference and reputed International/National journal.

The work to be pursued as a part of the dissertation shall be divided broadly in two parts, namely Dissertation I and Dissertation II.

The topic of the Dissertation should be such that it is a value addition for the existing knowledge in the field and has some worthwhile research input.

CE-510 Quality and Safety Management in Construction [3 0 0 3]

Course Objective:

- To introduce the students about quality and safety related challenges in construction industry.
- To make students aware about the globally recognized guidelines/theories for quality and safety in construction.
- To understand the importance of safety management in construction and the reduction of accidents on construction sites.

Course Syllabus:

Introduction to quality: Planning and control of quality during design of structures. Quantitative techniques in quality control. Quality assurance during construction. Inspection of materials and machinery. In process inspection and test. Preparation of quality manuals, check-list and inspection report. Establishing quality assurance system. Quality standards/codes in design and construction. Concept and philosophy of total quality management (TQM). Training in quality and quality management systems (ISO-9000). Concept of safety. Factors affecting safety; physiological, Psychological and Technological. Planning for safety provisions. Structural safety. Safety consideration during construction, demolition and during use of equipment. Management of accidents/injuries and provision of first aid. Provisional aspect of safety. Site management with regard to safety recommendations. Training for safety awareness and implementation. Formulation of safety manuals. Safety legislation, standards/codes with regard to construction. Quality vs Safety. Case Studies.

Course Outcome:

- Students will understand the concept of QC (quality control), quality assurance (QA) and TQM (Total Quality Management) in construction projects.
- Students will be able to recognize and evaluate occupational safety and health hazards onsite, and to determine appropriate hazard controls following the hierarchy of controls. Students will furthermore be able to analyze the effects of onsite exposures, injuries and illnesses, fatalities and the methods to prevent incidents at construction site.

Books Recommended:

1. Fox A J and Cornell H A "Quality in the Construction Projects" American Society of Civil Engineers, New York, 1992.
2. Hellard R B "Total Quality in Construction Projects: Achieving Profitability with Customer Satisfaction" Thomas Telford, London, 1993.
3. Davies V J and Thomasin K "Construction Safety Handbook" Thomas Telford, London, 1997.
4. Thorpe B "Quality Assurance in Construction" Gower, Aldershort, 1996.
5. NICMAR "Safety Management in Construction Industry – A Manual for Project Managers" NICMAR, Mumbai, 1998.
6. NICMAR "Handbooks of Safety in Construction" Vol. 1 to 6. NICMAR, Mumbai, 1998.

CE-511 Construction Economics and Finance [3-0-0-3]

Course Objective:

- To evaluate construction project economics, cost-benefit analysis, breakeven analysis and to analyze construction risks and uncertainties.
- Understand the importance of working capital management, budgeting and control.
- To study the need for financial management and means of achieving the same.
- Provide students with an economic perspective of the real estate and construction sectors, and an understanding of their roles on the general economy.

Course Syllabus:

Construction accounting, Income statement, Depreciation and amortization, Engineering economics, Time value of money, discounted cash flow, NPV, ROR, Pl, Bases of comparison, Incremental rate of return, Benefit-cost analysis, Replacement analysis, Break even analysis, Risks and uncertainties and management decision in capital budgeting. Taxation and inflation. Work pricing, cost elements of contract, bidding and award, revision due to unforeseen causes, escalation. Turnkey activities, Project appraisal and project yield. Working capital management, financial plan and multiple source of finance. International finance, Budgeting and budgetary control, Performance budgeting, appraisal through financial statements, Practical problems and case studies.

Course Outcome:

- On completion of this course the students will be able to know Life cycle costing, Financial Planning and Management for the construction project and Economical analysis of construction projects.
- Students will be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
- Students will understand the economic principles that underpin construction activities and will be able to use and apply cost planning and control techniques.

Books Recommended:

1. Palmer W J "Construction Accounting and Finance" McGraw hill, New Delhi, 1994.
2. Kuehal S C "Corporate Finance" Tata McGraw Hill, New Delhi, 1995.
3. Block S B and Geoffery A H "Foundations of Financial Management" McGraw Hill, London, 2001.
4. Singh H "Construction Management and Accounts" Tata McGraw Hill, New Delhi, 1993.

CE-512 Repair and Retrofitting of Structures [3-0-0-3]

Course Objective:

- To make students familiar about the understanding of the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- To make students Knowledgeable of different types of rocks and minerals and their physical properties.
- To make students Knowledgeable of in situ determination of engineering properties of rock masses.

- To make students understandable regarding the concepts of folds and faults, their classification and relation to engineering purposes.

Course Syllabus:

Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

Course Outcome:

- Understand the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- Knowledge of different types of rocks and minerals and their physical properties.
- Knowledge of in situ determination of engineering properties of rock masses.
- Understand the concepts of folds and faults, their classification and relation to engineering purposes.

Books Recommended:

1. Bungey J H “Testing of Concrete in Structures” Surrey University Press London, 1989.
2. Paulay T & Preistley “Seismic Design of Reinforced Concrete Structures and Masonry Buildings” John Wiley and Sons London, 1992.
3. ATC-40 (Vol. 1 & 2) “Seismic Evaluation and Retrofitting of Concrete Buildings” Applied Technology Council California, 1996.
4. FEMA – 273 “NEHRP Guidelines for Seismic Rehabilitation of Buildings” Building Seismic Safety Council Washington, 1997.
5. FEMA – 310 “Handbook for Seismic Evaluation of Buildings – a pre standard” Building Seismic Safety Council Washington, 1998.

6. Krammer S "Geotechnical Earthquake Engineering" Pearson Education pvt. Ltd. New Delhi, 2003.

CE 513 Advanced Numerical Methods [3-0-0-3]

Course Objectives:

- To understand the different numerical methods and presently available methods
- To be able to use different numerical methods for solving various geotechnical problems

Course Syllabus:

Introduction Solutions to linear equations, properties of matrices, Eigen values and Eigen vectors, solutions of linear systems; direct methods and iterative methods, Computation of Eigen values, solutions to the problems using programming languages (C, C++, FORTRAN, MATLAB).

Solutions of non linear equations, importance of non linear equations, different numerical techniques to solve non linear equations (Newton Raphson method, secant method, Aitken method).

Approximation of functions. Introduction, Taylor series, least squares, legendre polynomials, regression analysis.

Numerical differentiation and integration, ODE and PDE, truncation errors.

Course Outcomes:

- Student should be able to use different numerical methods for solving various geotechnical problems.

Text and Reference Books:

1. Chapra, S. C. and Canale R. P., 2003. Numerical Methods for Engineers. Tata McGraw Hill.
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., 1969. Applied Numerical Methods", John Wiley.
3. Heath, M. T., 1997. Scientific Computing : An Introductory Survey. McGraw Hill.
4. Rajasekaran, S., 1999. Numerical Methods in Science and Engineering. S. Chand.

CE 514 Highway Construction and Maintenance [3-0-0-3]

Course Objectives:

- To understand the requirement of materials and their role in pavements
- To gain knowledge of various types of failures in pavements and their specific remedy

Syllabus:

Materials for road construction: material properties (physical and chemical) of bitumen, cutback, emulsions, stabilizers, polymeric bitumen, elastomeric and plastomeric compounds, aggregates, coarse sand, stone dust, slags, river bed material, soil

Construction of low volume roads: Construction of Earth road, Construction of Gravel road, Construction of WBM roads

Flexible Pavement Construction: various layers: their advantages and requirements, standard materials' requirements, possible types of materials in different layers.

Construction of rigid pavements: various layers: their advantages and requirements, standard materials' requirements, possible types of materials in different layers.

Pavement maintenance and retrofitting: Pavement Failures, Pavement maintenance methods, Evaluation of pavement, Strengthening of existing pavements by overlaying, retrofitting of rigid pavements.

Course Outcome:

- The students will be able to evaluate the condition of pavement and specify requisite measure in terms of either pavement strengthening or maintenance.
- The course will enable students to make use of different materials in the specific layer of pavements.

Recommended Books:

1. Khanna, S. K and Justo, C.E.G. 1991. Highway engineering, Khanna Publishers.
2. Sharma and Sharma, 1980. Principles and practice of highway engg., Asia Publishing House.
3. Teng, 1980. Functional designing of pavements, Mc Graw - Hill.

CE-515 Theory of plates and Shells [3-0-0-3]

Course Objectives:

- To achieve fundamental understanding of the classical theory of plates and shells, address importance of plate and shell structures, introduce analytical solutions and numerical techniques and present detailed design of plate as well as shell structures.

Syllabus:

Plates: Introduction, Classification of pates, Governing equation of thin rectangular plate, Navier's Method of solution for Rectangular Plates subjected to point load, uniformly distributed load, patch load and linear hydro-static load, Levy's Solution, Bending of Orthotropic plates and Governing equation of thin rectangular plate, Analysis and Design of Grid flat thin slab system, Governing equation of Circular plate, Triangular plate and Elliptical plate, Structural behaviour of Folded plate roofs, Slab-beam analysis of folded plates, The vibration of plates.

Shells: Introduction, Type of shells, Equation of equilibrium of Spherical Shells, Design of Spherical shells with/without circular ring beam, Equation of Equilibrium of Conical Shells, Umbrella Shells, Conical water tank, Design of conical roof including edge beam, Equation of Equilibrium of cylindrical shells, Semi-circular shells, Circular cylindrical shells under axisymmetric loading, Analysis of doubly curved shells, Hipped roof.

Course Outcome:

- To enable students to apply the theory of plates and shells to problems, involving various geometries, loading and boundary conditions, to diverse problems in civil engineering and other related fields such as aerospace and mechanical engineering.

Recommended Books:

1. S. P. Timoshenko, and S. W. Krieger "Theory of Plates and Shells," McGraw-Hill, 1959.
2. B.K. Chatterjee, Theory and Design of Concrete Shells" Spon Press; Revised edition, 1988.
3. E.H. Mansfield "The Bending and Stretching of Plates," 2nd edition, Cambridge University Press, 1989.
4. H. Kruas, Thin Elastic Shells, John Wiley & Sons Ltd, 1968.
5. G.S. Ramaswamy, Design and Construction of Shell Structures, CBS Publishers, New Delhi, 1996.

6. E. Ventsel, and T. Krauthammer, Thin Plates and Shells: Theory, Analysis, and Applications, 1st Edition, CRC Press, 2001
7. K. Chandrasekhara, Analysis of Thin Concrete Shells, Oxford and IBH, Kolkata, 1971.
8. J.N. Bandopadhyay Thin Shell Structures, New Age International Publishers, New Delhi, 1986.
9. IS 2210-1988, Criteria for design of reinforced concrete shell structures and folded plates, Bureau of Indian Standards, New Delhi.

CE 516 Geospatial Technologies [3-0-0-3]

Course Objectives:

The goals of this course are to:

- Provide knowledge about the fundamentals of remote sensing, sensor systems and image characteristics
- Provide knowledge about the GPS system and its components, the GPS signal structure, the types of GPS measurements and their errors and biases.
- Provide an introduction to LIDAR data and discusses how to integrate and manage LIDAR data in GIS
- Enhance student understanding of characteristics of spatial data that come from different sources
- Enhance student understanding of data quality issues when integrating different data sources in GIS.

Course Syllabus:

Chapter–1: Geospatial Overview: Introduction to Geospatial Technology, Why to study, Geospatial Technology, Importance of Geospatial Technology.

Chapter–2: Mapping & Cartography: What is Map & its Importance, Map Scale and Types, Elements of Map and Indexing, Map Coordinate System, Interpretation of Satellite Images.

Chapter–3: Remote Sensing: Introduction, Spectral Reflectance Signature, Digital Image Processing, Visual Interpretation of Satellite data, Aerial Photo and Its Interpretation, Advanced Remote Sensing Technologies, Advantages and Benefits of RS, Overview on Remote Sensing Technology, Fundamentals of Remote Sensing, Physics of Electro Magnetic Energy, Remote

Sensing Platforms, Sensors and Data Products, Remote Sensing Applications, Indian Remote Sensing Systems.

Chapter–4: Geographic Information System (GPS): Introduction, Digital Cartography, Advantages and Benefits of GIS, GPS Accuracy and Accuracy factors, Types of GPS, List of Global Navigation System, GPS Today & Limitations of GPS, Uses of GPS Technology. GIS Data Element and Data Structure, Fundamentals of Database Concept, Data Input to GIS System, GIS Data Editing, Attribute Data Linking, Spatial and Non Spatial data Analysis, Map Projection and Coordinate System, Applications of GPS.

Chapter–5: Geographical Information System (GIS), Fundamentals of GIS, Components of GIS. GIS Acquisition of GIS, Data Types of GIS, Application of GIS.

Chapter-6: Trends in Geospatial Technology: Introduction, Remote Sensing Trends & Technology, GIS Trends & Technology, Web Based GIS, Enterprise GIS, Mobile GIS, 3-D Visualization and Fly through, Open GIS, GPS Trends & Technology.

Chapter–7: Applications of Geospatial Technology: Water shed Studies, Flood Studies, Ground water Studies, Health Issues, Utility Studies, Security and Defense Studies, Urban and infrastructure Studies

Course Outcomes:

Upon successful completion of the class, students should be able to:

- Critically evaluate and analyze data quality for their GIS project
- Design a geo-database and defend the data type selection
- Appraise the degree to which remote sensing data can be used efficiently and effectively
- Interpret the GPS signal and the factors that affect signal quality
- Interpret the significance of Dilution of Precision and its effect on position accuracies and evaluate correction techniques
- Decide and defend the use of raster versus terrain when performing analysis with LIDAR data
- Combine LIDAR data with multiple data sources to create more complex three-dimensional surfaces

Recommended Books:

1. Ahmed, El-Rabbany 2012. Introduction to GPS: the global positioning system, Second Edition; published by Artech House.
2. David, L., Verbyla 1995. Satellite remote sensing of natural resources, CRC Press.

CE-517 Prestressed Concrete Design [3-0-0-3]

Course Objective:

- To understand the general mechanical behavior of prestressed concrete.
- To analyze and design prestressed concrete flexural members.
- To analyze and design for vertical and horizontal shear in prestressed concrete.
- To analyze transfer and development length as well as prestress losses.
- To analyze and design for deflection and crack control of prestressed concrete member.

Course Syllabus:

Definition, Basic Principles, Types of prestressing, Systems of prestressing, Loss of prestress, materials used, Advantages and disadvantages. Critical load condition, Permissible stresses, Various suggested methods of design, Dimensionless Design variables, Solution of equations, Design Procedure based on flexure, Minimum weight design, Cable layout and profile of tendons, Design by load balancing method, Code provisions. Allowable stress considerations, Non-dimensionalised allowable stress equations and their solution, Shrinkage Stresses. Two span continuous beams and their analysis, Application of moment distribution method, Design of continuous beams, Continuous beams with variable section. One way and two way slabs, Beam and slab construction, Principal Stresses, failure due to shear, combined bending and shear, Bond, Prestressing cable at the centroidal axis, Symmetric multiple cable, cable with eccentricity, Inclined cables, Spalling and bursting stresses. Compression members, Tension members, Prestressed Concrete Pavements, Folded plates and Shells, Arches, Dams, Rigid frames, Cylindrical tanks.

Books Recommended:

1. Raju N K "Prestressed Concrete" Tata McGraw Hill, New Delhi, 2001.
2. Rajagopalan N "Prestressed Concrete" Narosa, New Delhi, 2002.
3. Dayaratnam P "Prestressed Concrete" Oxford & IBH, New Delhi, 2001.
4. Lin T Y "Prestressed Concrete" John Wiley and Sons, New York, 2002.

5. Nawy E G “Prestressed Concrete : A Fundamental Approach” Prentice Hall, New Delhi, 1995.
6. I.S. : 1343 – 1980 CODE, BIS New Delhi.

Course Outcome:

- Students will be able to identify and apply the applicable industry design codes relevant to the design of prestressed concrete members.
- Student will be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.
- Students will become familiar with the prestressed concrete fabrication and construction process.
- Students will be able to perform an industry relevant design project in a team setting.

CE-518 Infrastructure Development Projects [3-0-0-3]

Course Objective:

- To understand various concepts of infrastructure planning and management and know stages of an Infrastructure Project Lifecycle.
- To understand the role of Private sector and World Bank in infrastructure growth.
- To familiarize with the latest trends in Construction management, Construction materials and Construction machinery required for various types of infrastructure development project.

Course Syllabus:

Introduction: Meaning and Scope. Impact on economic development, standard of living and environment. Reasons for rise of public sector and government in infrastructural activities. Changed socio-economic scenario and current problems and related issues. Emerging trends in project contracting, from labour contracting to EPF turnkey jobs. Policies on infrastructure Development: A historical review of the Government policies on infrastructure. Current public policies on transportations, power and telecom sectors. Plans for infrastructure development. Reforming infrastructure: Reasons for and need of reforms: operations, maintenance and financial, technological and methodological considerations, Role of World Bank and other multilateral funding agencies in reform movement. Private Sector Participation: Options in infrastructure development and management. Commercial principles options and mechanisms of involvement. Joint Sector, corporatiozation, privatization and other means of financing. Experience of other countries.

Mechanisms: BOT, BOOT, BOO and other mechanisms. Experience of other countries and in India thus far. General guidelines on making Joint Ventures and private sector participation. Construction and Infrastructure: Construction component of various infrastructure sectors. Highway, ports and aviation, power, telecom, railways, irrigation. Current scenario, future needs, investment needed, regulatory framework, government policies and future plans. Technological and methodological demands and innovations on in constructors, construction Management: construction Management in infrastructure development projects. Training of construction managers. New trends in management and construction projects. Construction materials and machinery required for various types of infrastructure development projects. Innovations in technologies, methodologies and management in construction of infrastructure projects. International designs and specifications and techniques of project execution.

Books Recommended:

1. Vaid K "Construction and Infrastructure Development – Issues and Challenges" NICMAR, 2003.

2. India Infrasturcture Report 2001 & 2002, Oxford University Press, New Delhi, 2001/02

3. NICMAR, Construction Business Opportunities in Infrastructure Development in India, NICMAR, Mumbai, 2001.

4. Parikh K S "India Development Report 1999-2000" Oxford University Press, New Delhi, 1999.

5. Rakesh Mohan Committee "The India Infrastructure Report" National Council of Applied Economic Research, New Delhi, 1996.

Course Outcome:

After the completion of course, students will be able to:

- Gather background information and research and describe its impact on the infrastructure project.
- Understand the concepts of financial, economic, social and environmental impact and describe and explain how these are undertaken in an infrastructure project.

- Students will be able to understand the challenges and strategies for successful Infrastructure Project Implementation.

CE-519 Analysis and Design of Tall Buildings [3-0-0-3]

Course Objective:

- To make students aware about the structural elements and types of structural elements for tall buildings.
- To make analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- To make students knowledgeable of design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Course Syllabus:

Principles of Planning, Technological Planning, Mechanical systems, Fire rating, local consideration, structures elements, types of structural systems for tall buildings, Shear Walls and their arrangement. Loads on Tall Buildings, Gravity loads, live loads, wind loads and seismic loading, Code Provisions. Discussion of relevant codes of practices and loading standards. Analysis off Tall Buildings with and without Shear Walls, Approximate analysis for gravity loads, lateral loads. Analysis of tube-in-tube constructional and 3-Dimensional analysis of shear core buildings, stability, stiffness and fatigue, factor of safety and load factor, Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Course Outcome:

- Structural elements and types of structural elements for tall buildings.
- Analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

Books Recommended:

1 Schumelles W “High rise Building Structures” John Wiley and Sons, New York, 1977.

2. Ghali A “Structural Analysis: A Unified Classical and Matrix Approach” E & F Spon, London, 1999.

3. Taranath B S “Structural Analysis & Design of Tall Buildings” McGraw – Hill International, New York, 1988.

4. Brester B and Lin T Y “Steel Structures” John Wiley and Sons, New York, 1981.

5. Coull and Stafford S “Tall Buildings with Particular Reference to Shear Wall Structures” Pergamon Press, New York, 1967.

CE-526 Construction Methods and Equipment [3-0-0-3]

Course Objective:

- Properly select heavy equipment based on applications, utilization, productivity, and other factors
- Understand the elements of equipment cost and evaluating equipment owning alternatives.
- Have a basic understanding of various aspects of construction and earthwork, including but not limited to: concrete construction, Pile driving, tunneling, construction equipment and dewatering.

Course Syllabus:

Factors affecting selection of equipment technical and economic, construction engineering fundamentals, Analysis of production outputs and costs, characteristics and performances of equipment for Earth moving, Erection, Material transport, Pile driving, Dewatering, Concrete construction (including batching, mixing, transport and placement) and Tunneling.

Course Outcome:

- Learn how to best utilize construction equipment on site work and heavy civil projects.
- Become familiar with construction methods, equipment and their capabilities.
- Understand standard designations, sizes, and gradations of equipment.

Books Recommended:

1. Purifoy R L and Clifford J S “Construction Planning, Equipment and Methods: McGraw Hill, New York, 2002.

2. Verma M “Construction Equipment and its Planning and Application” Metropolitan Book company, New Delhi, 1994.
3. Singh J “Heavy Construction Planning, Equipment and Methods” Oxford and IBH, New Delhi, 1992.
4. NICMAR ‘Millennium Directory of Construction Equipment and Machinery Manufactured in India” CIRC, NICMAR, 2001.

CE-527 Design of Industrial Structures [3-0-0-3]

Course Objective:

- To qualify the students to analyse and design of various types of industrial buildings and to understand the design concept of Cold–formed light gauges steel sections.
- To understand the design concept of chimneys, cooling towers and bunkers
- To understand the design concept of trussed girder bridges and bearing
- To develop clear understanding of the concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.

Course Syllabus:

Planning of industrial structures, Design of braced and unbraced industrial portals in steel, Design of gantry girder, Design of single and multi bay industrial sheds in steel and concrete. Design of tie rods, sag rods, grit angles and purlins under action of dead, live and wind loads. Design of chimneys under combination of dead load, wind load and temperature stresses, Design of masts and cooling towers, Design of storage structures like bunkers and silos using Airy’s and Jensen’s theories. Design of large span roof structures and suspension roof structures, Machine foundations, Design of foundations for impact and rotary and reciprocating type machines. Analysis and design of Virendeel Girders.

Course Outcome:

- Capable of designing the industrial buildings with and without crane girders and students are capable enough to scrutinise the analysis and design of various industrial structures.
- Capable of designing the elements of steel construction.

- Capable of providing the design of concrete –Steel composite sections.
- Able to understand the analysis and design of trussed girder bridges and bearing.
- Able to analyze and design steel chimney, lattice tower and students able to independently design steel structures using relevant IS codes

Books Recommended:

1. Krishna Raju N "Advanced Reinforced Concrete Design" CBS Publishers, New Delhi, 2001.
2. Chandra R "Design of Steel Structures" Vol. II, Standard Publishers, Delhi, 1991.
3. Dayaratnam. P, "Design of Steel Structures" Wheeler Publishers, Allahabad, 1996.

CE-528 Advanced Steel Design [3-0-0-3]

Course Objective:

- To make students able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- To make students knowledgeable about the different configurations and components of elevated circular tanks.
- To make students aware about the design of light gauge steel.

Course Syllabus:

Plastic Design, Plastic Hinge, Plastic Collapse Load, Plastic Analysis of Frames; Wind Loads on Industrial Buildings, Braced and Unbraced Industrial Frames; Transmission Line Towers, Analysis by Tension Coefficients, Member Selection; Steel Tanks and Stacks, Different Configurations and components of Elevated Circular Tanks; Steel Stacks, Design Considerations; Design in Light Gauge Steel; Aluminum Structures; Residual Stresses.

Course Outcome:

- Able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- Different configurations and components of elevated circular tanks.
- Design of light gauge steel.

Books Recommended:

1. Dayaratnam P "Design of Steel Structures" Wheeler Publishers, Allahabad, 1996.
2. Arya A S and Ajmani J L "Design of Steel Structures" Nem Chand & Bros.,

Roorkee, 1996.

3. Raz S A “Structural Design in Steel”, New Age International Publishers, New Delhi, 2002.

4. Neal B G “Plastic Analysis of Structures” Chapman Hall, London, 1977

CE-529 Soil Dynamics and Machine Foundations [3-0-0-3]

Course Objective:

- Identification of dynamic loads and their characteristic.
- To apply theories of vibrations.
- Able to determine dynamic soil parameters.
- Understand the concept of Vibration isolation and screening.

Course Syllabus:

Nature of dynamic loads, stress conditions on Soil elements under E.Q. loading, Theory of vibrations, Behaviour of retaining walls during earthquakes, modification of Coulomb’s theory, Modified Culmann’s construction, Analytic solution for C- □□soils, Indian Standard Code of Practice, General, Failure Zones & ult. B.C. criteria for satisfactory action of a footing, Earthquakes loads on footings. Dynamic analysis for vertical loads, Theory, criterion of liquefaction, factor affecting, Laboratory studies on liquefaction in Triaxial shear and Oscillatory simple shear, Evaluation of Liquefaction Potential, Vibration table studies, Liquefaction behaviour of Dense sands, Introduction, Criteria for a satisfactory M/C foundation, Methods of analysis, Degrees of freedom of a Block foundation, soil spring stiffness, vibrations of a block I.S. for design of reciprocation M/c design procedure for Block Foundation, Vibration Isolation & Screening of Waves.

Course Outcome:

- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations.
- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Books Recommended:

1. Barken D D “Dynamics of Bases and Foundations” McGraw Hill, New York, 1962.
2. Saran S “Soil Dynamics and Machine Foundations”, Galogotia Publications Pvt. Ltd,New Delhi, 1999.
3. Rao N D V K “Vibration Analysis and Foundation Dynamics” Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi, 1998.
4. Prakash S “Soil Dynamics” McGraw Hill Book Company, New York, 1981.
5. Richart F E, Hall J R and Woods R D, “Vibrations of Soils and Foundations”, Prentice Hall International, N Jersey, 1970.
6. Krammer S “Geotechnical Earthquake Engineering” Pearson Education Pvt. Ltd. New Delhi, 2003.

CE-530 Construction and Contract Management [3-0-0-3]

Course Objective:

- To make Civil Engineering students able to analyze, evaluate and design construction contract documents.
- Resolve disputes collaboratively and amicably and outline alternative dispute resolution methods.

Course Syllabus:

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies, Qualification of bidders, Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, Conditions and specifications of contract. Contract administration, Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Cancellation Act 1996, Arbitration case studies, Professional ethics, Duties and responsibilities of parties, Management Information systems, Risk analysis, Value engineering.

Course Outcome:

Students will be able to

- Recognize different types of contracts and the effect of each type on the risk allocation strategy.

- Prepare contract schedules, notice inviting tender and contract documents.
- Apply contract administration tools and techniques to effectively manage the contract and avoid disputes during implementation.

Books Recommended:

1. Prakash V A "Contract Management in Civil Works Projects" NICMAR, 1997.
2. Richard C "Construction Contracting" John Wiley & sons, New York, 1986.
3. Ashworth A "Civil engineering Contractual Procedures" Longman, Harlow, 1998.
4. McCaffer R and Baldwin A N: Estimating and Tendering for Civil engineering works" Thomas Telford, London, 1991.
5. Thomas R "Construction Contract Claims" Macmillan, London, 1993.

CE 531 Geoenvironmental Engineering (3-0-0)

Course Objectives:

1. To make students aware about subsurface contamination and its sources
2. To make students learn about geotechnical aspects of planning and design of facilities for disposal of different kinds of solid waste
3. To make students learn about detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To make students learn about rehabilitation of waste dumps and geotechnical re-use of waste.

Course Syllabus:

Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and

field evaluation of permeability; Factors affecting permeability;

Waste disposal on land. Types of landfills : Sitting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.

Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

Course Outcomes:

Students will be to

- plan and design the facilities for disposal of different kinds of solid waste
- plan the detection and monitoring of subsurface contamination

Text and Reference Books:

1. Sharma, H. and Reddy, K.R., 2004. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Wiley.
2. Daniel, D.E., 1993. Geotechnical Practice for waste disposal. Chapman and Hall, London
3. Koerner, R.M., 2005. Designing with Geosynthetics. Prentice Hall, New Jersey
4. Reddi, L.N. and Inyang H.I., 2000. Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication

CE -532 Landfills And Ashponds (3-0-0)

Course Objectives

- To make students learn about design of waste disposal facilities
- To make students learn about the construction and operation of waste disposal facilities

Course Content

Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas. Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring. Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

Course outcomes

The student will be able to:

- To design the waste disposal facilities
- To contribute in construction and operation of the waste disposal facilities
- To plan the environmental monitoring around the waste disposal facilities.

Text and Reference Books:

1. Datta, M., 1998. Waste disposal in Engineered landfills, Narosa Publishers.
2. Reddy, L.N. and Inyang. H. I., 2000. Geoenvironmental Engineering –Principles and Applications, Marcel Dekker, Inc., New York
3. Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Townsend, T. G., 2015. Sustainable Practices for Landfill Design and Operation. Springer.

CE -533 Solid And Hazardous Waste Management (3-0-0)

Course Objectives

- To make students understand the components of solid waste management system
- To make students learn about recycling, reuse and reclamation of solid wastes

Course Content

Municipal Solid Waste : Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

Course outcomes

After this course student will be able to:

- To review the components of solid waste management system
- Appreciate the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste

- understand the importance and operation of a various facilities for resource recovery and waste disposal

Text and Reference Books:

1) Tchobanoglous, G., Vigil, S.A. and Theisen, H.,1993. Integrated Solid Waste Management: Engineering Principles and Management Issues, Mc-Graw Hill.
2) Pichtel, J., 2005. Waste Management Practices – Municipal, Hazardous and Industrial, CRC Press.
3) Vesilind, P.A., 2008. Solid Waste Engineering, Thomson Learning Inc.
4) Vesilind, P.A., Worrell, P.A., Reinhart, D., 2001. Solid Waste Engineering, Nelson Engineering.
5) Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.

CE-534 Concrete Mechanics [3-0-0-3]

Course Objective:

- To make students aware regarding the theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- To share the concepts of Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- To share the concepts of Statical and dynamical analysis of R. C. structures, trends.

Course Syllabus:

Introduction, Theological modeling of fresh concrete, Constitutive Equations: Nonlinear elasticity, plasticity, visco-elasticity and fracture mechanics of hardened concrete, confinement and ductility, Moisture diffusion: Permeability of Concrete, Drying creep and shrinkage cracking, solid and structural mechanics of reinforced concrete, Skew bending, modified compression field and unified theories of R.C. Beams under bending, shear and torsion, Bond-slip and phenomenon of cracking in reinforced concrete: Statical and dynamical analysis of R. C. Structures, Trends.

Course Outcome:

- Introduction, theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- Statical and dynamical analysis of R. C. structures, trends.

Recommended Books:

1. Jan G. M. van Mier "Fracture Processes of Concrete", CRC Press; 1 edition, 1997.
2. Carpinteri A. and Ingraffea A. R. "Fracture mechanics of concrete: material characterization and testing", Martinus Nijhoff Publishers, 1984.

CE-535 Recent Advances in Construction Materials [3-0-0-3]

Course Objective:

- To introduce the students with various types of construction materials required in specific places and situations.
- To provide the knowledge regarding construction of infrastructure with the use of these materials that involves designing the constituents, mixes and gradations.
- To gain knowledge regarding use of cheap alternative materials in place of high cost construction materials.

Course Syllabus:

Foams and lightweight materials, fibre reinforced concrete. Types of fibres, workability, mechanical and physical properties of fibre reinforced concrete, Industrial waste materials in concrete, their influence on physical and mechanical properties and durability of concrete, Concrete at high temperature, High strength concrete, changes in concrete with time, corrosion of concrete in various environments, corrosion of reinforcing steel, electro chemical process, measures of protection, Ferro-cement, materials and properties polymers Civil Engineering Polymers, fibres and composites, fibre reinforced plastic in sandwich panicles, modeling. Architectural use and aesthetics of composites. Adhesives and sealants. Structural elastomeric bearings and resilient seating. Moisture barriers, polymer foams and polymers in building Physics, Polymer concrete composites.

Course Outcome:

- The students will be able to make use of specific materials required for a given construction work.
- Course will enable them to decide the materials on basis of service life and expected performance on basis of their properties.

Recommended Books:

1. Marios, S. and Peter, D. 2017. Construction Materials: their nature and behavior, CRC Press.
2. David, D., and Cather, B. 2013. Construction materials reference book, Routledge.
3. Zhang, H. 2011. Building materials in civil engineering, Woodhead Publishing Series in Civil and Structural Engineering.
4. Hornbostel, C. 1991. Construction materials: types, uses and applications, John Wiley & Sons.
5. Duggal, S.,K. 1998. Building materials, New age international.
6. **Grosse**, Christian U., 2007. Advances in construction materials, **Grosse**, Christian U. (Ed.), Springer.

CE-536 Composite Materials [3-0-0-3]

Course Objective:

- To make students aware about the definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- To make students knowledgeable regarding the role of fibers in composites, comparison of fibres, role of interface in the fibre matrix composite.
- To make analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.

Course Syllabus:

Definition of Composite Materials, Classification of Composite Materials, Role of matrix in a composite materials, Polymer matrices, Classification of Polymer, Metal Matrices, Ceramic matrices, Comparison of polymer matrix, Metal matrix and ceramic Matrix, Role of fibres in composites, Comparison of Fibres, Role of interface in the fibre matrix composite.

Characterization of composites, Analysis of an Orthotropic Lamina and laminated Composites, Elastic properties of Unidirectional Laminate, cross ply laminate, Angle ply laminates, Short fibre composite materials, Experimental Characterization of Composites.

Course Outcome:

- Definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- Role of fibres in composites, comparison of fibres, role of interface in the fibre matrix composite.
- Analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.

Recommended Books:

1. Chawla, Krishan K. "Composite Materials: Science and Engineering (Materials Research and
2. Engineering)", Springer; 3rd edition, 2013.
3. Brandt A. M. "Cement-based Composites: Materials, Mechanical Properties and Performance", CRC Press, 1994.
4. Yang Y., Yu J., Xu H. and Sun B. "Porous lightweight composites reinforced with fibrous structures", Springer; 1st edition, 2017.

CE-537 Simulation & Modelling [3-0-0-3]

Course Objective:

- To impart the fundamental knowledge on using various analytical tools like STAAD Pro, ABAQUS, etc., for Engineering Simulation.
- Engineering problem modelling and solving through the relationship between theoretical, mathematical, and computational modelling for predicting and optimizing performance and objective.
- To impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools.

- Develop solutions and extract results from the information generated in the context of the engineering domain to assist engineering decision making.

Course Syllabus:

Introduction: Mathematical models, numerical models and Physical models. Deterministic and stochastic models. Concepts of simulation.

Competitive situations: Optimization, Single and multiple objectives optimizations, Pareto optimal solutions. Introduction to linear and geometric programmings. Zero degree and single degree of difficulty.

Growth and Decay processes: Discrete and continuous systems. Differential and Integral equation approach, Fibonacci growth.

Probability Distributions: Binomial and Poisson distributions, Normal, Lognormal and pareto distributions.

Generation of random numbers: Uniform variable, normal and lognormal variables.

Queing theory: Montecarlo methods, solutions of Laplace equations in two dimensions.

Course Outcome:

- The student will be able to appreciate the utility of the tools like STAAD Pro or ABAQUS in solving real time problems and day to day problems.
- Use of these tools for any engineering and real time applications.
- Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.

Recommended Books:

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, Discrete Event system Simulation, Pearson Education, Asia, 4th Edition, 2007, ISBN: 81-203-2832-9.

2. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4.

3. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.

4. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN: 0-87692-028-8.

CE-538 Site Investigations and Ground Improvement [3-0-0-3]

Course Objective:

- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

Course Syllabus:

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions. Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Report writing. Safety measures.

Geotechnical Processes: Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control. Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.

Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis, lime column. soil-lime column. Grouting: permeation, compaction and jet. Vibro floatation, dynamic compaction, thermal, freezing. Dewatering systems.

Course Outcome:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization.

- Students will learn about geosynthetics and their properties.
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Recommended Books:

1. Peck R B, Hanson W B and Thorn Burn T H "Foundation Engineering" John Wiley and Sons Inc, New York, 1974.
2. Teng W C "Foundation Design" Prentice Hall of India Pvt. Ltd., New Delhi, 1977.
3. Bowles J E "Foundation Analysis and Design" McGraw Hill, New York, 1982.
4. Saran S "Analysis and Design of Substructures", Oxford & IBH Publishing Co. (P) Ltd., New Delhi, 1996.
5. Coduto, Donald P"Foundation Design", Pearson Education International, New Jersy, 2001

CE-539 Engineering Behaviour of Soils [3-0-0-3]

Course Objective:

- To understand the mechanical stress, strain and strength of soil.
- To understand the critical state soil mechanics.
- Apply fundamental knowledge of the behaviour of soil as an engineering material in Civil Engineering Projects.
- Analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Course Syllabus:

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure. Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability. Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters.

Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters.

Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters. Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours. Factors affecting strength : stress history, rate of testing, structure and temperature. Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength. Stress-strain characteristics of soils. Determination modulus values. Critical state model.
Engineering Behaviour of soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

Course Outcome:

- Students will be able to determine the stress, strain of soil, critical state of soil.
- Students will have knowledge regarding the behaviour of soil as an engineering material in Civil Engineering Projects.
- Students will learn to analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Books Recommended:

1. Mitchell, James K., (1993), "Fundamentals of soil Behaviour", 2nd Edition, John Wiley and sons.
2. Das, B.M., (1997), "Advanced soil Mechanics", Taylor and Francis.
3. Lambe, T.W., and Whitman, R.V., (1987), "Soil Mechanics", John Wiley and Sons.
4. Gulhati, Shashi K., and Datta Manoj (2008), "Geotechnical Engineering, Tata Mcgraw-Hill Company Ltd.
5. Coduto, Donald P (2002), "Geotechnical Engineering, Principles and Practices",
Pearson Education International, New Jersy.

CE-540 Geosynthetics [3-0-0-3]

Course Objective:

- Understand different the basics of Geosynthetics
- Identify the geosynthetic materials and its applications.
- To get familiar with using different geosynthetics for improvement of bearing capacity and soil texture.

Course Syllabus:

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences. Geosynthetics in Pavements:

Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.

Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

Course Outcome:

- Students should be able to distinguish between different geosynthetics.
- Students should be able to determine the properties of geosynthetics.
- Students should be able to determine the bearing capacity of soil after introducing geosynthetics.

Recommended Books:

1. Rao G V and Raju S "Engineering with Geosynthetics" Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990.

2. Ranjan G and Rao A S R "Basic and Applied Soil Mechanics" International Publishers, New Delhi, 2000.

3. Koerner R M "Designing with Geosynthetics" Prentice-Hall, N. J., U.S.A., 1986.

4. Saran, S., (2006), "Reinforced soil and its Engineering Applications", I.K. International Pvt. Ltd.

5. Jones, C.J.F.P. (1985), "Earth Reinforcement and soil structures", Butterworth and co. (Publishers) Ltd., London, England.

CE-541 Pavement Analysis, Design and Construction (3-0-0-3)

Course Objectives

1. To study the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations.
4. To introduce the constructions of different types of highway pavements.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Course Syllabus

Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories , ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.

Flexible Pavement Design: Various approaches for designing the highway and airport pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements (highways and airports) and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods, design of joints

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement consruction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc.

Evaluation and Strengthening:

Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, overview of the revision of specifications pertaining to these methods, design of different overlays, skid resistance and measurement

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of low volume roads.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;
5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
4. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
5. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
6. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
7. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
8. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.

9. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.
10. Chakraborty, P. and Das, A., 2013. Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).
10 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

11. Yoder E.J. and Witzack M.W., 1991. Principles of Pavement Design; John Wiley and Sons, New York.
12. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi
13. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
14. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
15. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.
IRC: 58-2015. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.
IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi
IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

ID 601 Research Methodology [3-0-0-3]

Course Objectives:

- To understand research and research process.
- To acquaint students with identifying problems for research and develop research strategies.
- To familiarize students with the techniques of data collection, analysis of data and interpretation.

Course Syllabus:

Thinking Process: role of thinking in research, levels and styles of thinking, common sense and scientific thinking, examples.

Problem solving: problem solving strategies- reformulation or rephrasing, techniques of representation, logical thinking, division into sub problems, verbalization, awareness of scale, importance of graphical representation, examples.

Experimental and modelling skills: census and sample survey, sampling procedure, important scaling techniques, methods of data collection, estimation and reduction of random errors, detection and elimination of systematic error, guideline for constructing questionnaire, scientific method role of hypothesis in experiment, hypothesis testing, F test, t-test, chi square test, use of ANOVA.

Types of models, the art of making approximations, problem representation, logical reasoning, mathematical skills, techniques of numerical simulation.

Problem finding and literature survey: information gathering reading searching and documentation, types, attributes and sources of research problem; problem formulation, relative importance of various forms of publication; choice of journal entries using process, difference between publishing and patenting.

Effective communication-oral and written: examples in straightening the importance of effective communication, stages and dimensions of a communication process.

stress management time management interpersonal skills professional ethics: psychological faces of a PhD process, stress points, managing self, teamwork, sense of humor, plagiarism and research ethics.

Course Outcome:

Learner will be able to…

- Prepare a preliminary research design for projects in their subject matter areas.
- Accurately collect, analyze and report data.
- Present complex data or situations clearly.
- Review and analyze research findings.

Recommended Books:

1. E.M. Phillips and D S Pugh, ― How to get a PhD – a handbook for PhD student s and their supervisors, Viva books Pvt. Ltd for all scholars irrespective of their disciplines.
2. Handbook of Science Communication, compiled by Antony Wilson, Jane Gregory, Steve Miller, Shirley Ear, Overseas Press Indian Pvt. Ltd, New Delhi, first edition 2005.
3. G L Squires, ―Practical physics, Cambridge University Press for all scholars except those from Humanities and Management sciences.
4. Peter B Medeq, ― Advice to a Young Scientist, Pan Books, London 1979.

CE 590 Modelling and Research Methodology [3-0-0-3]

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Syllabus:

UNIT –I Research methodology

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

UNIT –II Literature survey

Importance of literature survey -Sources of information -Assessment of quality of journals and articles -Information through internet. Literature review: Need of review -Guidelines for review -Record of research review.

UNIT –III Research design

Meaning of research design -Need of research design -Feature of a good design -Important concepts related to research design -Different research designs -Basic principles of experimental design -Developing a research plan -Design of experimental set-up -Use of standards and codes of Civil Engineering.

UNIT –IV Data collection and analysis:

Collection of primary data and Secondary data of different Civil Engineering fields -Data organization -Methods of data grouping -Diagrammatic representation of data -Graphic representation of data -Sample design -Need for sampling -Some important sampling definitions -Estimation of population -Role of statistics for data analysis -Parametric vs. non parametric methods -Descriptive statistics -Measures of central tendency and dispersion -Hypothesis testing -Use of statistical softwares. Data Analysis: Deterministic and random data -Uncertainty analysis -Tests for significance -Chi-square -Student’s t-test -Regression modeling -Direct and interaction effects –ANOVA-F-test -Time series analysis -Autocorrelation and autoregressive modeling.

UNIT –V Research report writing:

Format of the research report –Synopsis –Dissertation -Thesis -Its differentiation –References – Bibliography -Technical paper writing -Journal report writing -Making presentation -Use of visual aids. Research proposal preparation: Writing a research proposal and research report -Writing research grant proposal.

Course Outcome:

- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.

- Process research data to write research report for grant proposal.

Recommended Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. 2002. An introduction to research methodology, RBSA Publishers.
2. Kothari, C.R, 2004. Research methodology, methods & technique, New Age International Publishers, New Delhi.
3. Ganesan, R. 2015. Research methodology for engineers, MJP Publishers, Chennai.
4. Khananabis, Ratan and Saha, Suvasis 2015. Research methodology, Universities Press, Hyderabad.
5. Agarwal,Y.P. 2004. Statistical Methods: concepts, application and computation, Sterling Publishing Pvt. Ltd., New Delhi.
6. Upagade, Vijay and Shende, Aravind 2009. Research methodology, S. Chand & Company Ltd., New Delhi.
7. Nageswara Rao, G. 2012. Research methodology and quantitative methods, BS Publications, Hyderabad.

Teaching scheme and syllabus for PG Diploma in Civil Engineering: Geotechnical & Geoenvironmental Engineering specialization

Enclosure #5(b)

CURRICULUM

PG Diploma in Civil Engineering

with specialization in

(GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING)

(July 2019 admission onwards)

APPROVED BY

BOARD OF STUDIES (BOS)

12th MEETING, February 20, 2019

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,

Jalandhar

Teaching Scheme

Semester – I

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - I	3	0	0	3
CE	Course - II	3	0	0	3
CE	Course - III	3	0	0	3
CE	Course - IV	3	0	0	3
CE	Course - V	3	0	0	3
CE	Lab-I	0	0	3	2
CE	Lab-II	0	0	3	2
Total					19

Semester - II

Course No.	Course Title	Periods			Credits
		L	T	P/D	
CE	Course - VI	3	0	0	3
CE	Course - VII	3	0	0	3
CE	Course - VIII	3	0	0	3
CE	Course - IX	3	0	0	3
CE	Course - X	3	0	0	3
CE	Lab-III	0	0	3	2
CE	Lab-IV	0	0	3	2
Total					19

Note: 6 Core theory courses, 4 elective courses and 4 laboratories (or industrial projects, where 1 industrial project is equivalent to 2 laboratory courses) need to be completed for the degree.

Grand Total of Credits = 38

List Of Core Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-539	Engineering Behaviour Of Soils	3	0	0	3
2.	CE-551	Design Of Substructures	3	0	0	3
3.	CE-552	Soil Dynamics And Earthquake Engineering	3	0	0	3
4.	CE-531	Geoenvironmental Engineering	3	0	0	3
5.	CE-533	Solid And Hazardous Waste Management	3	0	0	3
6.	CE-513	Advanced Numerical Methods	3	0	0	3
7.	CE-601	Independent Study	0	0	6	3
8.	CE-600	Dissertation Part-I Dissertation Part-II	0	0	30	6+12

List Of Laboratory Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-561	Materials Testing And Characterization Laboratory	0	0	2	1
2.	CE-562	Soil Engineering Laboratory	0	0	2	1
3.	CE-563	Advanced Water And Wastewater Laboratory	0	0	2	1
4.	CE-564	Simulation Laboratory	0	0	2	1

List Of Elective Courses For M.Tech Geotechnical And Geoenvironmental Engineering

S. No.	Course Code	Course Title	Hrs/Week			Credits
			L	T	P	
1.	CE-501	Advanced Solid Mechanics	3	0	0	3
2.	CE-540	Geosynthetics	3	0	0	3
3.	CE-532	Landfills And Ashponds	3	0	0	3
4.	CE-553	Environmental Risk Assessment	3	0	0	3
5.	CE-554	Finite Element Method in Geotechnical Engineering	3	0	0	3
6.	CE-555	Subsurface Hydrology	3	0	0	3
7.	CE-556	Mechanics of Sediment Transport	3	0	0	3
8.	CE-557	Water Resources Systems	3	0	0	3
9	CE-558	Geotechnical Investigations and Ground Improvement	3	0	0	3
10	CE-559	Earth Dams and Stability Of Slopes	3	0	0	3
11	CE-560	Emerging Topics In Geotechnical Engineering	3	0	0	3
12	CE-566	Pavement Geotechnics and Material	3	0	0	3
13	CE-567	Rock Mechanics	3	0	0	3
14	CE-568	Engineering Geology	3	0	0	3
15	CE-569	Environmental Impact Assessment	3	0	0	3
16	CE-570	Environmental System Analysis	3	0	0	3
17	CE-571	Risk and Reliability in Geotechnical Engineering	3	0	0	3
18	CE-572	Constitutive Models for Soil	3	0	0	3
19	CE-573	Natural Treatment Systems	3	0	0	3
20	CE-541	Pavement Analysis, Design and Construction	3	0	0	3

21	CE-574	Watershed Management and Remote Sensing Applications	3	0	0	3
22	CE-590	Modelling and Research Methodology	3	0	0	3

SYLLABUS

CE 539 Engineering Behaviour of Soils (3-0-0)

Course Objectives

- To understand the mechanical stress, strain and strength of soil
- To understand the critical state soil mechanics
- Apply fundamental knowledge of the behaviour of soil as an engineering material in Civil Engineering Projects
- Analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement

Course Syllabus

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure.
Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability.
Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters.
Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear beahviour. Determination of parameters.
Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours.
Factors affecting strength : stress history, rate of testing, structure and temperature.
Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength.
Stress-strain characteristics of soils. Determination modulus values.
Critical state model. Engineering Behaviour of soils of India : Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

Course outcomes

- Students will be able to determine the stress, strain of soil, critical state of soil
- Students will have knowledge regarding the behaviour of soil as an engineering material in Civil Engineering Projects
- Students will learn to analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement

Text and Reference Books:

1. Mitchell, J. K., 1993. Fundamentals of soil Behaviour. Edition, John Wiley and sons, New York
2. Das, B.M., 1997. Advanced soil Mechanics. Taylor and Francis.
3. Lambe, T.W. and Whitman, R.V., 1987. Soil Mechanics. John Wiley and Sons
4. Gulhati, S. K. and Datta M. 2008. Geotechnical Engineering. Tata Mcgraw-Hill Company Ltd.

5. Coduto, D. P. 2002. Geotechnical Engineering, Principles and Practices. Pearson Education International, New Jersey.

CE 551 Design of Substructures (3-0-0)

Course Objectives:

- To be able to develop deeper understanding of shallow and deep foundations
- To be able to develop understanding of different design parameters
- To be able to design reinforced retaining wall

Course Syllabus:

Shallow Foundations: Depth, Spacing of footings, Erosion problems, Water table effects, foundations on sands, Silts, Clays, landfills (qualitative treatment only). Introduction to design of Spread footings, Rectangular footings, and Eccentrically loaded spread footings, Basics of beams on elastic foundation and Ring foundations.

Mat Foundations: Types, Bearing capacity, Settlements, Sub grade reaction, Design guidelines.

Deep Foundations: Tension piles, Negative skin friction, and under-reamed piles. Guidelines for design of pile caps, Batter piles, Laterally loaded piles- Ultimate capacity of laterally loaded piles. Drilled piers – Uses, load carrying capacity, Settlements.

Retaining Walls, MSE Walls, Sheet Piles, Well Foundations, Cofferdams

Course Outcomes:

- Students should be able to design shallow and deep foundations
- Students should be able to determine different design parameters
- Students should be able to design reinforced retaining wall

Text and Reference Books:

1. Das, B.M., 1999. Principles of Foundation Engineering. Cengage Learning, Singapore.
2. Bowles, J. E. 1988. Foundation Analysis and Design. Mc Graw Hill, New York.
3. Swami, S., 2009. Analysis and Design of Substructures. Oxford & IBH Publishing Company Pvt. Ltd.

CE 552 Soil Dynamics And Earthquake Engineering (3-0-0)

Course Objectives:

1. Identification of dynamic loads and their characteristic.
2. To apply theories of vibrations.
3. Able to determine dynamic soil parameters.
4. Understand the concept of Vibration isolation and screening.

Course Syllabus:

Nature of dynamic loads, stress conditions on Soil elements under E.Q. loading,
Theory of vibrations, Behaviour of retaining walls during earthquakes, modification of Coulomb's theory, Modified Culmann's construction,
Analytic solution for C- ϕ soils, Indian Standard Code of Practice, General, Failure Zones & ult. B.C. criteria for satisfactory action of a footing, Earthquakes loads on footings.
Dynamic analysis for vertical loads, Theory, criterion of liquefaction, factor affecting, Laboratory studies on liquefaction in Triaxial shear and Oscillatory simple shear, Evaluation of Liquefaction Potential, Vibration table studies,Liquefaction behaviour of Dense sands,

Introduction, Seismology and earthquakes, continental drift and plate tectonics, elastic Rebound theory, location and size of earthquakes. Ground motion parameters & their estimation, Seismic Hazard Analysis - Deterministic and Probabilistic. Wave Propagation,
Ground Response Analysis - one, two and three dimensional ground response analysis.

Introduction, Criteria for a satisfactory M/C foundation, Methods of analysis, Degrees of freedom of a Block foundation, soil spring stiffness, vibrations of a block I.S. for design of reciprocation M/c design procedure for Block Foundation, Vibration Isolation & Screening of Waves.

Course Outcomes:

- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations

- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Text and Reference Books:

1. Barken, D. D.,1962. Dynamics of bases and foundations. McGraw Hill, New York.
2. Saran, S., 1999. Soil Dynamics and Machine Foundations. Galogotia Publications Pvt. Ltd, New Delhi.
3. Rao, N. D. V. K., 1998. Vibration Analysis and Foundation Dynamics. Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi.
4. Krammer, S., 2003. Geotechnical Earthquake Engineering. Pearson Education Pvt. Ltd. New Delhi.
5. Prakash, S., 1981. Soil Dynamics. McGraw Hill Book Company, New York.

CE 531 Geoenvironmental Engineering (3-0-0)

Course Objectives:

1. To make students aware about subsurface contamination and its sources
2. To make students learn about geotechnical aspects of planning and design of facilities for disposal of different kinds of solid waste
3. To make students learn about detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To make students learn about rehabilitation of waste dumps and geotechnical re-use of waste.

Course Syllabus:

Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability;

Waste disposal on land. Types of landfills : Sitting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.

Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

Course Outcomes:

Students will be to

- plan and design the facilities for disposal of different kinds of solid waste
- plan the detection and monitoring of subsurface contamination

Text and Reference Books:

1. Sharma, H. and Reddy, K.R., 2004. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Wiley.
2. Daniel, D.E., 1993. Geotechnical Practice for waste disposal. Chapman and Hall, London
3. Koerner, R.M., 2005. Designing with Geosynthetics. Prentice Hall, New Jersey
4. Reddi, L.N. and Inyang H.I., 2000. Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication

CE -533 Solid And Hazardous Waste Management (3-0-0)

Course Objectives

- To make students understand the components of solid waste management system
- To make students learn about recycling, reuse and reclamation of solid wastes

Course Content

Municipal Solid Waste : Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

Course outcomes

After this course student will be able to:

- To review the components of solid waste management system
- Appreciate the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste
- understand the importance and operation of a various facilities for resource recovery and waste disposal

Text and Reference Books:

1) Tchobanoglous, G., Vigil, S.A. and Theisen, H.,1993. Integrated Solid Waste Management: Engineering Principles and Management Issues, Mc-Graw Hill.
2) Pichtel, J., 2005. Waste Management Practices – Municipal, Hazardous and Industrial, CRC Press.
3) Vesilind, P.A., 2008. Solid Waste Engineering, Thomson Learning Inc.
4) Vesilind, P.A., Worrell, P.A., Reinhart, D., 2001. Solid Waste Engineering, Nelson Engineering.
5) Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.

CE 513 Advanced Numerical Methods (3-0-0)

Course Objective:

- To understand the different numerical methods
- To be able to use different numerical methods for solving various geotechnical problems

Course Syllabus:

Introduction Solutions to linear equations, properties of matrices, Eigen values and Eigen vectors, solutions of linear systems; direct methods and iterative methods, Computation of Eigen values, solutions to the problems using programming languages (C, C++, FORTRAN, MATLAB)

Solutions of non linear equations, importance of non linear equations, different numerical techniques to solve non-linear equations (Newton Raphson method, secant method, Aitken method)

Approximation of functions. Introduction, Taylor series, least squares, legendre polynomials, regression analysis

Numerical differentiation and integration, ODE and PDE, truncation errors

Course Outcomes:

- Student should be able to use different numerical methods for solving various geotechnical problems

Text and Reference Books:

1. Chapra, S. C. and Canale R. P., 2003. Numerical Methods for Engineers. Tata McGraw Hill
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., 1969. Applied Numerical Methods", John Wiley
3. Heath, M. T., 1997. Scientific Computing : An Introductory Survey. McGraw Hill
4. Rajasekaran, S., 1999. Numerical Methods in Science and Engineering. S. Chand

CE 501 Advanced Solid Mechanics (3-0-0)

Course Objectives:

Course Syllabus:

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

Course Outcomes:

Text and Reference Books:

1. Timoshenko S P and Goodier J N "Theory of Elasticity" McGraw Hill, New York, 2002.
2. Housner G W and Vreeland J R "The Analysis of Stress and Deformation" Mcmillan London, 1998.
3. Srinath L S "Advanced Mechanics of Solids" Tata Mcgraw Hill, New Delhi, 2000.
4. Westergaard H M "Theory of Elasticity and Plasticity" Harvard University Press,

Cambridge, 1998.
5. Kazimi S M A “Solid Mechanics” Tata McGraw Hill, New Delhi, 1999.

CE -532 Landfills And Ashponds (3-0-0)

Course Objectives

- To make students learn about design of waste disposal facilities
- To make students learn about the construction and operation of waste disposal facilities

Course Content

Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas. Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring. Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

Course outcomes

The student will be able to:

- To design the waste disposal facilities
- To contribute in construction and operation of the waste disposal facilities
- To plan the environmental monitoring around the waste disposal facilities.

Text and Reference Books:

1. Datta, M., 1998. Waste disposal in Engineered landfills, Narosa Publishers.
2. Reddy, L.N. and Inyang. H. I., 2000. Geoenvironmental Engineering –Principles and Applications, Marcel Dekker, Inc., New York
3. Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Townsend, T. G., 2015. Sustainable Practices for Landfill Design and Operation. Springer.

CE 540 Geosynthetics (3-0-0)

Course Objectives:

- Understand different the basics of Geosynthetics
- Identify the geosynthetic materials and its applications.
- To get familiar with using different geosynthetics for improvement of bearing capacity and soil texture

Course Syllabus:

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences.

Geosynthetics in Pavements:

Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.

Geosynthetics in Environmental Control:

Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

Course Outcomes:

- Students should be able to distinguish between different geosynthetics
- Students should be able to determine the properties of geosynthetics
- Students should be able to determine the bearing capacity of soil after introducing geosynthetics

Text and Reference Books:

1. Shukla, S. K. and Yin, J. H., 2006. Fundamentals of Geosynthetics Engineering. Taylor and Francis.
2. Shukla, S. K., 2002. Geosynthetics and their Applications. Thomson Telford.
3. Han, J.,1964. Principles and Practices of Ground Improvement. John Wiley & Sons, Inc., New Jersey.
4. Rao, G. V. and Raju, S., 1990. Engineering with Geosynthetics. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Koerner, R. M., 1986. Designing with Geosynthetics. Prentice-Hall, N. J., U.S.A.
6. Saran, S., 2006. Reinforced soil and its Engineering Applications. I.K. International Pvt. Ltd.

CE 553 Environmental Risk Assessment (3-0-0)

Course Objectives

- To introduce concepts of environmental risk assessment to the students
- To teach mathematical approaches to quantify different risk assessment components.

Course Content

Basic concepts of environmental risk and definitions; Human health risk and ecologial risk assessment framework; Hazard identification procedures and hazard prioritization; Environmental risk zonation; Consequence analysis and modelling (discharge models, dispersion models, fire and explosion models, effect models etc). Estimation of incident frequencies from historical data, frequency modelling techniques e.g., Fault tree analysis (FTA) and Event tree analysis (ETA), Reliability block diagram. Case Studies. Human factors in risk analysis; Risk management & communication. Rules, regulations and conventions.

Course outcomes

The student will be able to:

- To understand the concept of environment risk assessment.
- To implement mathematical tools to assess environmental risk .

Text and Reference Books:

1. Devore, J.L., Probability and Statistics for Engineering and the Science. Latest edition, Thomson Learning Inc.
2. Kammen, D.M., and Hassenzahal, D.M., Should we risk it?: Exploring environmental, health, and technological problem solving. Latest edition, Princeton University Press.
3. DeGroot, M.H. and Schervish, M.J. Probability and Statistics. Latest edition, Addison-Wesley.
4. Johnston, J. and DiNardo, J., Econometric methods. Latest edition, The McGraw-Hill Companies, Inc.

CE 554 Finite Element Method in Geotechnical Engineering (3-1-0)

Course Objectives:

- To implement the basics of FEM to relate stresses and strains.
- To solve one, two and three dimensional and dynamic problems using Finite Element Analysis.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements;
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Syllabus:

Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, Some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

Course Outcome:

- Implement numerical methods to solve mechanics of solids problems.
- Formulate and Solve axially loaded bar Problems.
- Formulate and analyze truss and beam problems.
- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
- Formulate and solve Axi-symmetric and heat transfer problems.

Text and Reference Books:

1. Zienkiewiez O. C., 1991. The Finite Element Method. Mcgraw Hill, London.
2. Abel, J. F. and Desai, C. A., 2004. Finite Element Method. Van Nostrand Reinhold, New York.
3. Reddy, J.N., 2003. An Introduction to the Finite Element Method. Tata McGraw Hill, New Delhi.
4. Bathe, K. J. 1997. Finite Element Procedures. Prentice Hall of India Private Limited, New Delhi.
5. Chandrupatla, T. R. and Belegundu, A. D. 1997. Introduction to Finite Elements in Engineering" Prentice Hall of India Private Limited, New Delhi.

CE 555 Subsurface Hydrology (3-0-0)

Course Objectives:

- To understand the mechanism of ground water flow
- To get familiar with transport processes in porous media
- To identify the sources of ground water

Course Syllabus:

Fundamentals of subsurface flow and transport, role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Groundwater recharge, water logging and salinity; infiltration and exfiltration from soils in absence and presence of a water table; modelling contaminant transport through porous media: dispersion, adsorption and decay, volatilization; applications of numerical models (GMS, FEFLOW, PMWIN, etc.) in hydrogeology; model conceptualization, discretization and calibration, initial and exit boundary conditions.

Text and Reference Books:

1. Bear, J., Dynamics of Fluids in porous Media, Dover Publications, 1972.
2. Fetter, C.W., Contaminant Hydrogeology, Prentice Hall, 1999.
3. Bear, J. and Verruijt, A., Modelling Groundwater Flow and Pollution, Reidel Publishing Company, 1990.
4. Fetter, C.W., Applied Geohydrology, Prentice Hall, 2001.

Course Outcomes:

- Students should be able to distinguish amongst ground water and surface water
- Students should be able to quantify the flow in groundwater in different saturated zones.
- Students should be able to determine the quality and quantity of ground water and its sources.

CE 556 Mechanics of Sediment Transport (3-0-0)

Course Objectives:

- To understand the mechanism of sediment transport
- To get familiar with the dynamics of natural streams
- To know about behaviour and maintenance of open channels

Course Syllabus:

Fluvial sediments; transportation and entrainment; physical & chemical characteristics; grain size distribution;

Introduction to sediment: Physical properties of fluid and sediment, origin and properties of sediments, nature of problems.

Fluvial hydraulics: Scour criteria and problems: regimes of flow, Shields curve, incipient motion of sediment particles, terminal fall velocity of sediment in fluid, alluvial bed forms and Resistance to flow.

Sediment transport: Bed load, suspended load and total load transport, Meyer-Peter approach, du Boys' approach, Einstein's approach, Engelund and Fredsøe's approach, sediment samplers, design of stable channels, alluvial stream and their hydraulic geometry.

Turbulent Fluvial Flows: Decomposition and averaging procedure, equation of motion (Reynolds equations), Prandtl's mixing length theory, hypothesis of von Kármán, velocity distribution, the linear law in viscous sub-layer, the logarithmic law in turbulent wall shear layer, law in buffer layer, log-wake law and velocity defect law, turbulence intensity, calculation of bed shear stress using bed slope, velocity distribution, average velocity, Reynolds shear stress distribution, turbulent kinetic energy distribution.

River Training Works: Objectives, classification of river training works, design of guide banks, groynes or spurs their design and classification ISI Recommendations of approach embankments and afflux embankments, pitched islands, artificial cut-offs, objects and design considerations, river control-objectives and methods.

Sediment control: Silt management, management of canal in Punjab, Bhakra calal, delta formation.

Text and Reference Books:

Dey, Subhasish, "Fluvial Hydrodynamics" 2014, Springer, India

Garde, R.J., Raju, K.G.R, "Mechanics of Sediment Transportation and Alluvial Stream Problems" 1985, Wiley Eastern Ltd.

Yang, C.T., "Sediment Transport: Theory and Practice." 1996, McGraw-Hill, USA.

Yalin, M.S., "Mechanics of Sediment Transport" 1977, Pergamon Press, Oxford.

Course Outcomes:

- Students should be able to evaluate the quantity of sediment transport in alluvial channels
- Students should be able to analyse the flow structure on deformable boundaries
- Students should be able to take initiative to protect the rivers by erosion and deposition

CE 557 Water Resources Systems (3-0-0)

Course Objectives:

- To understand the complex water resources processes
- To get familiar optimization techniques and algorithm in reservoir operation
- To analyse the economics and social impact of water resources projects

Course Syllabus:

Basic concepts of systems, need for systems approach in water resources, system design techniques, problem formulation; optimization techniques, LP, NLP, dynamic programming, genetic algorithm, sensitivity analysis, capacity expansion; reservoir operation problems, simulation, case studies; planning, role of a planner, National water policies, public involvement, social impact, economic analysis.

Text and Reference Books:

1. Loucks, D.P., Stedinger, P.J.R., Haith, D.A., Water Resources Systems Planning and Management, Prentice Hall, New Jersy, 1987.

2. Hall, K., A and Draoup, J.A., Water Resources Systems Engineering, Tata McGraw Hill, 1970.

3. Neil, G.S., Water Resources Planning, McGraw Hill, 1985.

4. National Water Policy, Ministry of Water Resources, Government of India, 1987.

Course Outcomes:

- Students should be able to understand the water resources system and its management
- Students should be able to evaluate the quantity of water in various resources of water
- Students should be able to optimize the use of water for different purposes
- Students should be able to carry out the sensitivity, economic and social impact analysis of water projects.

CE 558 Geotechnical Investigations And Ground Improvement (3-0-0)

Course Objectives:

- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

Course Syllabus:

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic

refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions.
Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties.
Report writing. Safety measures.
Geotechnical Processes:
Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control.
Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.
Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electroosmosis,
lime column. soil-lime column. Grouting : permeation, compaction and jet. Vibrofloatation, dynamic compaction, thermal, freezing. Dewatering systems

Course Outcomes:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization
- Students will learn about geosynthetics and their properties
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Text and Reference Books:

1. Peck, R. B., Hanson, W. B. and Thornburn, T. H., 1974. Foundation Engineering. John Wiley and Sons Inc, New York.
2. Teng, W. C. 1977. Foundation Design. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Schnaid, F., 2009. In Situ Testing in Geomechanics. Taylor and Francis.
3. Bowles, J. E., 1982. Foundation Analysis and Design. McGraw Hill, New York.
4. Coduto, D. P., 2001. Foundation Design. Pearson Education International, New Jersey.

CE 559 Earth Dams And Stability of Slopes (3-0-0)

Course Objectives:
Have an understanding of seismic design concepts and current practices for earth dams and other similar structures to enable them to plan and direct the construction activity appropriately.

Understand the soil dynamic testing procedure and methodology of seismic design to be able to execute a proper design.
Have a clear understanding of design methodology and the interpretation in the seismic codes.

Course Syllabus:

Earth and Rockfill Dams: Selection Criteria, Classification, Causes of failure, Instrumentation, Stress Measurements
Nature and Importance of failure, Piping through embankment, design of filters, Types of failure, Rockfill dams

Course Outcomes:

At the end of the course, the student will be able to:
Describe the behaviour of natural and engineered soil / rock slopes under various weather and engineering conditions.
Explain the factors that may affect the stability of slopes.
Select an appropriate slope stability analysis method subject to geometry of slope, material properties, and uncertainty of observations.
Assess the potential landslide risk of slopes.

Text and Reference Books:

1. Hoek, E. and Bray, J.W., 1981. Rock Slope Engineering. Institution of Mining Engineering
2. Giani, G.P.,1992. Rock Slope Stability Analysis. A A Balkema
3. Wyllie, D. C. and Christofer, W. M., 2004. Rock Slope Engineering. Taylor and Francis.
4. Singh, B. and Goel, R.K., 2002. Software for Engineering Control of Landslides and Tunneling Hazards. A A Balkema.
5. Harr, M.E., 1962. Ground Water and Seepage. McGraw Hill.
6. Chowdhary, R. and Chowdhary, I., 2009. Geotechnical Slope Analysis. CRC Press.

CE 560 Emerging Topics In Geotechnical Engineering (3-0-0)

Course Objectives:

- To provide the idea of old and new techniques, new machinery and construction equipments
- To discuss about different trends in laboratory testing, soil behaviour, construction techniques

Course Syllabus:

A course which will vary from year to year to study new and exicting developments in the broad spectrum of Geotechnical and Geoenvironmental Engineering. The course will also focus on new offshoots of Geotechnical and Geoenvironmental Engineering.
Trends in Site investigation, laboratory testing, design and analysis, ground improvement, underground structures, soil behaviour, construction techniques

Course Outcomes:

- Students should be able to decide on the techniques, machinery and equipments which will be economical as well as beneficial to carry out the required tasks

Text and Reference Books:

1. Mitchell, J. K., 1993. Fundamentals of soil Behaviour. Edition, John Wiley and sons, New York
2. Das, B.M., 1997. Advanced soil Mechanics. Taylor and Francis.
3. Lambe, T.W. and Whitman, R.V., 1987. Soil Mechanics. John Wiley and Sons
4. Gulhati, S. K. and Datta M. 2008. Geotechnical Engineering. Tata Mcgraw-Hill Company Ltd.
5. Coduto, D. P. 2002. Geotechnical Engineering, Principles and Practices. Pearson Education International, New Jersey.
6. Shukla, S. K. and Yin, J. H., 2006. Fundamentals of Geosynthetics Engineering. Taylor and Francis.
7. Schnaid, F., 2009. In Situ Testing in Geomechanics. Taylor and Francis.

Along with the books, reference to different journals, conferences, workshop notes, magazones to be referred which highlight the new trends in geotechnical engineering

CE 566 Pavement Geotechnics and Material

Course Objectives

1. To study the significance of soil subgrade along with its functions, desirable properties of soil as a highway material, soil classification for highway engineering purpose as per different classification system and evaluation of properties.
2. To understand the concept of the mechanics of stresses in soils and characterization of the important properties of the soil to be used in the design.
3. To know the functions of sub-base, base and surface courses of the pavement and understand the geotechnical properties and behaviour of the different geomaterials including stabilized geomaterials, bituminous materials.
4. To know the various ground improvement techniques in the highway construction.
5. To know the significance of the highway / storm water drainage in the network of highway in rural and urban area including hilly region.

Course Syllabus

Subgrade: Functions, importance of subgrade soil properties, subgrade soil classification for highway engineering purpose, evaluation of properties, compaction system.

Stresses in soils: Theories and elastic and plastic behaviour of soils, methods of reducing settlement, estimation of rate of settlement due to consolidation; foundation of road embankment, static and cyclic triaxial test on subgrade soils. Resilient deformation, resilient strain, resilient modulus, CBR test, effect of lateral confinement on CBR and E value of subgrade soil; static and cyclic plate bearing test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture contents, etc.

Material characterization: Functions, geotechnical properties of geomaterials (soils, rocks, soil and rock mixtures, and recycled and alternative materials) for rational and sustainable design and construction, behavior of compacted geomaterials, behavior of stabilized geomaterials (mixtures of soils with - cement, lime, fly ash, polymers and other kind of geomaterials), compaction technology, compaction management, maintenance technology;

Aggregates: Different types, desirable properties, various tests for evaluation of these properties, recommended values as per specification.

Bituminous Materials: Different grades, types of bituminous surfaces, desirable properties and tests for evaluating these properties, Marshall's stability test, bituminous mix design.

Ground Improvement Techniques: Different methods of soil stabilization, use of geosynthetics and fibers, etc. in the highway subgrade and highway construction, other ground improvement techniques (sand drains, band drains, stone columns, gabions, etc.) in the context of highway construction, reinforced earth.

Highway Drainage: General principles, significance, different drainage systems (surface/ sub-surface), drainage systems in the hilly areas, pumping systems, water body, holding ponds, frost action, frost susceptible soils, depth of frost penetration, loss of strength during frost melting, etc., design of drainage systems.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the soil classification in accordance with various prevailing classification system and evaluate the ability of the soil as a subgrade material.

2. Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
3. Understand the characterization of different paving materials along with the tests to be conducted on these materials.
4. Understand the basic deficiencies in the soils to be used as a highway materials and various ways and means of improving the soil and implementing the techniques of ground improvement.
5. Understand the implications of appropriate drainage system for the appropriate performance of the roads, various drainage systems in rural, urban and hilly regions and design the drainage system.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Srinivasakumar, R., 2013. A Text Book of Highway Engineering; University Press, Hyderabad
4. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
5. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
6. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
7. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
8. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
9. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.
10. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.

11. Chakraborty, P. and Das, A., 2013. , Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).
10 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

11. Yoder E.J. and Witzack M.W. ,1991. Principles of Pavement Design; John Wiley and Sons, New York.
12. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi
13. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
14. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
15. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.

IRC: 58-2011. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.

IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi

IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

CE 567 Rock Mechanics (3-0-0)

Course Objectives:

- To impart to students the knowledge of the basic mechanics which governs the behaviour of rocks and rock masses so that they can understand the mechanics of structures constructed in/on them.

Course Syllabus:

Definition, Application of Rock Mechanics, Stress and Strain in Rock, Physico - mechanical Properties of Rock, Dynamic Properties of Rock and Rockmass, Time Dependent Properties of Rock, Behaviour of Rockmass, Failure Criteria for Rock and Rockmass, Pre-mining State of Stress

Course Outcomes:

- Students will be able to distinguish between different rocks, kind of failure in rocks, different types of tests in rocks and the bearing capacity of rocks

Text and Reference Books:

1. Hudson, J.A. and Harrison, J. P., 2000. Engineering Rock Mechanics- An Introduction to the Principles. Elsevier
2. Jaeger, J.C. and Cook, N.G.W., 1979. Fundamentals of Rock Mechanics. Mathew & Co. Ltd.
3. Singh, B. and Goel, R.K., 2006. Rock Mass Classification- A Practical Engineering Approach. Elsevier.
4. Hoek, E., 2000. Practical Rock Engineering. Rock Science.
5. Ramamurthy, T., 2008. Engineering in Rocks. PHI Learning Pvt. Ltd.

CE 568 Engineering Geology (3-0-0)

Course Objectives

- Awareness about earth resources and processes to be considered in various facets of civil engineering

- Appreciation of surface of earth as the fundamental foundation structure and the natural phenomena that influence its stability

Course Syllabus:

Relevance of geology in Civil Engineering. Subdivisions of Geology. Interior of the earth. Weathering, its engineering significance and laboratory tests used in civil engineering. Soil profile. Hydrogeology-occurrence of groundwater, Types of aquifers and their properties. Engineering significance of subsurface water in construction. Methods to control of subsurface water. Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of common rock forming minerals Earth quakes- in relation to internal structure of earth and plate tectonics Types of rocks. Brief account of selected rocks. Rock features that influence the strength of rocks as construction material. Rock types of Kerala. Engineering properties of rocks. Attitude of geological structures- strike and dip. Deformation structures and their engineering significance. Geological factors considered in the construction of engineering structures. Introduction to natural hazards and their management. Coastal Processes and protection strategies. Soil erosion and conservation measures.

Course Outcomes:

- The course would help the student to understand of the factors that determine the stability of earth’s surface
- The student would comprehend better the earth resources used as building materials

Text and Reference Books:

1. Duggal, S.K., Rawal, N. and Pandey, H.K., 2014. Engineering Geology, McGraw Hill Education, New Delhi.
2. Garg, S.K., 2012. Introduction to Physical and Engineering Geology, Khanna Publishers, New Delhi.
3. Gokhale, K.V.G.K., 2010. Principles of Engineering Geology, BS Publications, Hyderabad 4. Kanithi, V., 2012. Engineering Geology, Universities Press (India) Ltd., Hyderabad
5. Singh, P., 2004. Engineering and General Geology, S. K. Kataria and Sons, New Delhi
6. Bennison, G.M., Olver, P.A. and Moseley, K.A., 2013. An introduction to geological structures and maps, Routledge, London
7. Gokhale, N.W., 1987. Manual of geological maps, CBS Publishers, New Delhi

CE 569 Environmental Impact Assessment

Course Objectives

- To expose the students with the methods of qualitative and quantitative assessment of environmental impacts due to developmental activities.

- To make the students learn planning for mitigation of adverse impact on environment.
- To expose students to the analysis of case studies on environmental impact assessment

Course Content

The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA. List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. Identifying the Key Issues.

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.

Review of Environmental Management Plan and Monitoring. Case Studies.

Course outcome

The student will be able to:

- To review the key concepts of environmental impact assessment and the current legislation covering it
- To prediction and assess the impact from an activity /project on land, water, air, flora and fauna

Text and Reference Books:

1. Sadler, B. and McCabe, M., 2002. Environmental Impact Assessment: Training Resource Manual. UNEP.

2. Rau J. G. and Wooten D. C., 1980. Environmental Impact Analysis Handbook, Tata McGraw-Hill.

3. MOEF, India, EIA manual. Ministry of Environment and Forests, Government of India (http://www.envfor.nic.in/legis/eia/so195.pdf).

4. Canter, R. L., Environmental Impact Assessment, Tata McGraw-Hill (1981).

CE 570 Environmental System Analysis

Course Objectives

- To expose students to a systems approach based mathematical framework for addressing environmental problems.
- To train students in defining systems and their boundaries, apply appropriate algorithms and optimize systems for a set of constraints and objectives.

Course Content

Introduction to natural and man-made systems. Systems modeling as applied to environmental systems. Nature of environmental systems, the model building process addressing to specific environmental problems. Strategies for analyzing and using environmental systems models. Fate and transport models for contaminants in air, water, and soil. Optimization methods (search techniques, linear programming, non-linear programming, dynamic programming) to evaluate alternatives for solid-waste management and water and air pollution control. Optimization over time. Integrated environmental management strategies addressing multi-objective and multi-stakeholder planning.

Course outcomes

The student will be able to:

- To describe and use different environmental system analysis tools.
- To assess strengths and weaknesses for different tools
- To present and critically discuss the results from an environmental system analysis perspective.

Text and Reference Books:

1. Sven E. Jorgensen, 1999. A Systems Approach to the Environmental Analysis of Pollution Minimization. CRC Press.
2. Tanimoto, Jun. 2014. Mathematical Analysis of Environmental System. Springer, 2014
3. Haith, D. A., 1982. Environmental Systems Optimization. John Wiley & Sons, New York, NY.

CE 571 Risk and Reliability in Geotechnical Engineering (3-0-0)

Course Objectives:

- To introduce graduate students the concepts and application of risk and reliability
- To be able to compute first- and second-order estimates of failure probabilities of engineered systems
- To be able to update reliability estimates based on new observational data
- To be able to identify the relative advantages and disadvantages of various analytical reliability methods, as well as Monte Carlo simulation

Course Syllabus:

Introduction: Sources and types of uncertainties associated with geotechnical analysis, importance of probabilistic methods and reliability based analysis in geotechnical engineering Review of probability and statistics: Discrete and continuous random variables, parameter estimation, testing of hypothesis, regression analysis Fundamentals of reliability analysis: First Order Second Moment (FOSM) method, First Order Reliability Method (FORM), Second Order Reliability Method (SORM), Monte Carlo simulation Application towards geotechnical problems: Characterization of uncertainty in field measured and laboratory measured soil properties, uncertainty in interpretation techniques Spatial variability of soil properties, scale of fluctuations, estimation of auto correlation and auto covariance Probabilistic groundwater modeling, flow through earth dams Probabilistic slope stability analysis Fundamentals of LRFD design methodology, reliability based design of shallow and deep foundations, settlement analysis Reliability based liquefaction analysis, lateral spreading Development of fragility curves for geotechnical problems

Course Outcomes:

- Students will be able to compute first- and second-order estimates of failure probabilities of engineered systems
- Students will be able to measure the relative importance of the random variables associated with a system;
- Students will be able to update reliability estimates based on new observational data
- Students will be able to identify the relative advantages and disadvantages of various analytical reliability methods, as well as Monte Carlo simulation

Text and Reference Books:

1. Phoon, K. and Ching, J., 2015. Risk and Reliability in Geotechnical Engineering. Taylor and Francis, New York.
2. Baecher, G.B. and Christian, J.T., 2003. Reliability and Statistics in Geotechnical Engineering. John Wiley and Sons, Sussex, England
3. Modarres, M., Kaminskiy, M. and Krivtsov, V. 1999. Reliability Engineering and Risk Analysis - A Practical Guide. Marcel Dekker Inc, Basel, New York.
4. Halder, A. and Mahadevan, S., 2000. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley.
5. Ang, A.H.S. and Tang, W. H., 1975. Probability Concepts in Engineering Planning and Design. Wiley.

CE 572 Constitutive Models for Soil (3-0-0)

Course Objectives:

- To introduce fundamentals of constitutive modelling of soils
- Students will learn elastic, viscoelastic, plastic, viscoplastic material responses and continuum damage mechanics
- Students will learn how microstructural mechanisms influence the macroscopic mechanical behavior in different materials

Course Syllabus:

Stress strain relationships. Definition of stress and strain tensors. Elasticity. Linear Elasticity. Generalized Hooke's law. Field equations in linear elasticity.

Linear elasticity and incrementally non-linear elastic formulation. Stress-strain relationships, strength and volumetric response. Evaluation of model parameters. Incremental finite element analyses.

Plasticity theory. Incrementally linearized elasto-plastic formulation. Linear elastic-perfectly plastic. Critical state soil mechanics framework (Cam-clay and modified cam-clay models). Drained and undrained response of clays. Effects of consolidation stress history.

Compressibility of soils. Yielding for soils. Stress and strain history. Plastic hardening. Evolving anisotropy. Small strain non-linear "elastic" response. Hysteretic response. Large strain failure criteria: Von Mises, Drucker-Prager, Mohr Coulomb.

Course Outcomes:

- Students will learn the fundamentals of constitutive models
- Students will learn various kinds of elastic and inelastic, e.g, plastic, viscoplastic, viscoelastic, material response
- Students should be able to develop constitutive models

Text and Reference Books:

1. Desai, C.S., 2000. Mechanics of Materials and Interfaces:The Disturbed State Concept. CRC Press LLC.
2. Desai, C.S. and Siriwardane, H. J., 1984. Constitutive Laws for Engineering Materials with Emphasis on Geologic Materials. Prentice-Hall, Inc., New Jersey.
3. Hicher and Shao, 2008. Constitutive Modeling of Soils and Rocks. John Wiley
4. Potts, D. M. and Zdravkovic, L., 1999. Finite Element Analysis in Geotechnical Engineering Theory. Thomas Telford.
5. Selvadurai, A.P.S. and Boulon, M. J., 1995. Mechanics of Geomaterial Interfaces, Elsevier.

CE 573 Natural treatment Systems (3-0-0)

Course Objectives

- To provide knowledge regarding natural wastewater treating technologies
- To provide know-how for designing a low cost and sustainable wastewater treatment system

Course Content

Introduction: Natural wastewater treatment Systems (NWTS), Main Types Of NWTS, Advantages And Disadvantages Of NWTS, Flows And Loads, Preliminary Treatment.

Septic tanks, Waste stabilization ponds - Facultative Ponds, Maturation Ponds, Polishing Ponds, Physical Design, Sampling And Performance Evaluation, Operation And Maintenance, WSP Design Example, Case Study. Rock filters: Types Of Rock Filter, Un-aerated Rock filter for BOD And SS Removal, Aerated Rock filter for Ammonia Removal.

Constructed wetlands: Types Of Constructed Wetlands, Free-Water-Surface CW, Subsurface Horizontal-Flow CW, Vertical-Flow CW, Physical Design, Operation and Maintenance, Compact Vertical Flow-CW Treating Raw Wastewater, Nitrification, Denitrification, Phosphorous removal, heavy metal removal, CW Design Examples.

Application of Constructed wetlands for urban floods: Case studies and design examples.

NWTS technology selection: Comparative Costs, Technology Selection.

Course outcomes

The student will be able to:

- Design a low cost, sustainable wastewater treatment system.
- Practically implement NTS systems for field applications
- Appreciate wider applications of natural treatment systems

Text and Reference Books:

1. Kadlec, R.H., Wallace, S., 2008. Treatment Wetlands, CRC Press.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engg, McGraw Hill, International Edition.
3. Garg, S.K., Environmental Engineering (Vol. II), Khanna Publishers, Delhi.

4. Metcalf and Eddy, 2017. Wastewater Engineering: Treatment and Reuse, McGraw Hill Education.
5. IWA, 2017. Treatment Wetlands. IWA Publishing. https://doi.org/10.2166/9781780408774

CE 541 Pavement Analysis and Design (3-0-0)

Course Objectives

1. To study the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations.
4. To introduce the constructions of different types of highway pavements.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Course Syllabus

Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories , ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.

Flexible Pavement Design: Various approaches for designing the highway and airport pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements (highways and airports) and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods, design of joints

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement consruction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc.

Evaluation and Strengthening:

Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, overview of the revision of specifications pertaining to these methods, design of different overlays, skid resistance and measurement

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of low volume roads.

Course Outcomes

On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;

5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.

Books Recommended:

1. Sharma, S.K., 2014. Principles, Practice and Design of Highway Engineering (Including Airport Engineering); S. Chand and Company Pvt. Ltd., New Delhi.
2. Srinivasakumar, R., 2015. Pavement Design; University Press, Hyderabad (First Published 2013; Preprinted in 2015).
3. Kadiyali, L.R.and Lall, N.B., 2005. Principles and Practice of Highway Engineering; Khanna Publishers, Delhi
4. Yang H. Huang, 2008. Pavement Analysis and Design; Pearson Prentice Hall, USA
5. Das, Animesh, 2017. Analysis of Pevement Structures; CRC Group, Taylor and Francis Group
6. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2015. Highway Engineering; Nem Chand and Bros., Roorkee (Revised 10th Edition).
7. Saxena, Subhash Chandra, 2014. A Text Book of Highway and Traffic Engineering; CBS Publishers and Distributors, New Delhi
8. Venkatramaiah, C., 2016. Transportation Engineering (Vol.-I)- Highway Engineering.; University Press, Hyderabad.
9. Rao, G.V., 2000. Principles of Transportation and Highway Engineering; Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi.
10. Chakraborty, P. and Das, A., 2013. Principles of Transportation Engineering, Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).
11 Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A., 2013. Highway Material and Pavement Testing; Nem Chand and Bros., Roorkee, India.

Reference Books

16. Yoder E.J. and Witzack M.W., 1991. Principles of Pavement Design; John Wiley and Sons, New York.
17. Kandhal, Prithvi Singh , 2014. Bituminous Road Construction in India; PHI Learning Pvt. Ltd., Delhi

18. Delattee, Norbert J., 2017. Concrete Pavement: Design, Construction and Performance (Second Edition)
19. Mallick, Rajib B. and Korchi, Tahar El, 2017. Pavement Engineering: Principles and Practice, CRC Press, Taylor and Francis Group (Third Edition)
20. Nikolaides, A., 2017. Highway Engineering: Pavement Materials and Control of Quality, CRC Press, taylors and Francis Group.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. / Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:

IRC: 37-2012. “Tentative Guidelines for the Design of Flexible Pavements,” Indian Road Congress, Delhi.

IRC: 58-2015. “Tentative Guidelines for the Design of Rigid Pavements,” Indian Road Congress, Delhi.

IRC: 81-2012. “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique,” Indian Road Congress, Delhi

IRC: SP: 76-2008. “Tentative Guidelines for Conventional, Thin and Ultra-Thin White-topping,” Indian Road Congress, Delhi.

Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

CE 574 Watershed Management and Remote Sensing Applications (3-0-0)

Course Objectives:

- To understand the catchment management system
- To get familiar with remote sensing and their link with surface properties
- To identify the satellite and their use in Civil Engineering Profession

Principles of watershed management, soil water conservation practices, integrated planning, multi-disciplinary approach, management of agricultural lands - structural and non-structural measures, forest and grass land management, erosion problems and controlling techniques, gully control, landslide and correction techniques, soil water plant relationships, watershed modeling.

Remote sensing: fundamentals – physics of remote sensing – electromagnetic radiation,interaction of ENR with atmosphere, earth surface, soils, water and vegetation. Data acquisition, photographic system and imaging systems, single vertical photographs, visible and near infrared imagery, photo interpretation, visual analysis, spectral properties of water, photogrammetry, stereoscopic viewing, application to water resources mapping, area assessment and watershed management – satellite data – geo-coding – GPS and GIS utilities – classification using imageries – applications in water resources and watershed management – case studies.

Text and Reference Books:

1. Lillesand, K., Remote Sensing and Image Interpretation, John Wiley & Sons, 1979.

2. Tideman, E.M., Watershed Management – Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi, 1996.

3. FAO Watershed management and Field manual, 13/1, 13/2,13/3,13/4,13/5 FAO, UN, Rome, 1988.

4. Reeves, R.G., Manual of Remote Sensing, Volume I and II, American Society of Photogrammetr, Falls Church, 1975.

Course Outcomes:

1. Introduction to basis of GIS and watershed management includes conservation soil.
2. Understand the mapping process and geographical coordinate system of earth.
3. Able to do vector based and raster based data processing.
4. Knowledge of remote sensing and its components.
5. To apply integration of remote sensing and GIS.

LABORATORY

CE 561 Materials Testing And Characterization Laboratory (0-0-3)

Course Objectives

- The objective is to characterize the geosynthetics and waste materials used in construction industry

List of Experiments

- Specific gravity of available waste material
- Shear tests of waste material and geosynthetics, stress paths
- Hydrometer analysis of waste materials

Course Outcomes

- Students should be able to perform the various tests on geosynthetics as well as waste materials

CE 562 Soil Engineering Laboratory (0-0-3)

Course Objectives:

- The objective is to learn to perform basic tests on soil and determine the properties of various soils

List of Experiments

- Determination of relative density
- Vane shear test
- Consolidation tests
- Direct shear and tri-axial compression test – UU, CU, CD tests ,Influence of strain rate, Stress path testing etc.
- Standard penetration tests 5. Dynamic cone penetration tests
- Plate load tests
- Hydrometer Test

Course Outcomes

- Students should be able to perform different tests on soils

|CE 563 Advanced Water and Wastewater Laboratory (0-0-3)

Course Objectives

- To enable the students in analysing the physical and chemical characteristics of water and wastewater
- To familiarize the students with the methods to estimate the organic strength of wastewater

Course Content

Principles of instrumentation and application for water quality parameters measurements.
Indicative list of experiments:
Physical and Chemical Characteristics of Water - pH, Electrical Conductivity, Turbidity, Alkalinity, Acidity, Hardness, Sulphates, Fluorides, Nitrates; Estimation of Solids (TSS, TDS, VSS, FSS); Estimation of Nitrogen (Ammonical Nitrogen, Nitrite, Nitrate, TKN); Estimation of Phosphates and Sulphates; Determination of heavy metals using AAS; Determination of COD using spectrophotometer; Ambient Air Quality Analysis - Determination of SPM, CO, NO_X and $SO_{X;}$ Soil Analysis - pH, Conductivity, Cation Exchange Capacity, Sodium Adsorption Ratio.

Course Outcomes

Students will be able to

- To conduct experiments as per standard methods of sampling and analysis.
- To demonstrate the expertise to characterize water and wastewater samples.
- To understand the importance of laboratory analysis as a controlling factor in the treatment of water and wastewater**.**

Text and Reference Books:

1. Sawyer,C.N., McCarty, P.L. and Parkin,G.F., (2002). Chemistry for Environmental Engineering and Science. 5th edition, McGraw-Hill Publishing Company.
2. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2012.

CE 564 Simulation Laboratory (0-0-3)

Course Objectives

- To be able to write a computer code for different numerical methods

List of Experiments

- Introductory exercises on MATLAB and other software
- Simulation using MATLAB – an exercise on a simulation method
- Development of algorithms/codes by considering different methods for: roots of equations
- Solution of simultaneous equation (linear-nonlinear),
- Eigen value and Eigen vectors
- Numerical integration
- Solution of differential equation

Course Outcomes

- Students should be able to write basic codes for different numerical methods and apply the codes for problems in geotechnical engineering

CE 590 Modelling and Research Methodology

Course Objectives

1. Learn the research types, methodology and formulation.
2. Know the sources of literature, survey, review and quality journals.
3. Understand the research design for collection of research data.
4. Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes

1. Differentiate the research types and methodology.
2. Able to do literature survey using quality journals.
3. Able to collect research data.
4. Process research data to write research report for grant proposal.

Course Syllabus

UNIT –I Research methodology

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

UNIT –II Literature survey

Importance of literature survey -Sources of information -Assessment of quality of journals and articles -Information through internet. Literature review: Need of review -Guidelines for review -Record of research review.

UNIT –III Research design

Meaning of research design -Need of research design -Feature of a good design -Important concepts related to research design -Different research designs -Basic principles of experimental design -Developing a research plan -Design of experimental set-up -Use of standards and codes of Civil Engineering.

UNIT –IV Data collection and analysis:

Collection of primary data and Secondary data of different Civil Engineering fields -Data organization -Methods of data grouping -Diagrammatic representation of data -Graphic representation of data -Sample design -Need for sampling -Some important sampling definitions -Estimation of population -Role of statistics for data analysis -Parametric vs. non parametric methods -Descriptive statistics -Measures of central tendency and dispersion -Hypothesis testing -Use of statistical softwares. Data Analysis: Deterministic and random data -Uncertainty analysis

-Tests for significance -Chi-square -Student's t-test -Regression modeling -Direct and interaction effects –ANOVA-F-test -Time series analysis -Autocorrelation and autoregressive modeling.

UNIT –V Research report writing: Format of the research report –Synopsis –Dissertation -Thesis -Its differentiation –References –Bibliography -Technical paper writing -Journal report writing -Making presentation -Use of visual aids. Research proposal preparation: Writing a research proposal and research report -Writing research grant proposal.

Text and Reference Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. 2002. An introduction to research methodology, RBSA Publishers.
2. Kothari, C.R, 2004. Research methodology, methods & technique, New Age International Publishers, New Delhi.
3. Ganesan, R. 2015. Research methodology for engineers, MJP Publishers, Chennai.
4. Khananabis, Ratan and Saha, Suvasis 2015. Research methodology, Universities Press, Hyderabad.
5. Agarwal,Y.P. 2004. Statistical Methods: concepts, application and computation, Sterling Publishing Pvt. Ltd., New Delhi.
6. Upagade, Vijay and Shende, Aravind 2009. Research methodology, S. Chand & Company Ltd., New Delhi.
7. Nageswara Rao, G. 2012. Research methodology and quantitative methods, BS Publications, Hyderabad.