DEPARTMENT OF CIVIL ENGINEERING

Course Book for
B. Tech. in Civil Engineering

Visvesvaraya National Institute of Technology, Nagpur

July 2017

Brief about Civil Engineering Department:

Civil Engineering Department is the oldest department in this institute right from the establishment of Government College of Engineering in Nagpur 1956. The department offers the undergraduate course of B.Tech in Civil Engineering and Four Postgraduate Courses of M.Tech as given below.

Program	Description
UG in Civil Engineering	Started with 60 seats in 1956
	Intake increased to 71 in 2008
	Intake increase to 82 in 2009
	Intake increase to 92 in 2010

PG in Civil Engineering Department
1. Environmental Engineering   Started in 1966 (32 seats)
2. Water Resources Engineering   Started in 2005 (20 seats)
3. Construction Technology and Management   Started in 2010 (20 seats)
4. Transportation Engineering   Started in 2012 (20 seats)

VISION:

To contribute effectively to the National Endeavour of producing quality human resource of world class standard in Civil Engineering by developing a sustainable technical education system to meet the changing technological needs of the Country incorporating relevant of social concerns and to build an environment to create and propagate innovative technologies for the economic development of Nation.

MISSION:

The Mission of the undergraduate Civil Engineering program is to develop students into capable civil engineering graduates by imparting appropriate high quality education in Civil Engineering so that they could be readily adapted by the service sector to meet the challenges faced by the Nation. The program strives for excellence in engineering education and profession. It also aims to promote all round development of the personality of students by suitably involving them in Co-curricular and extra-curricular activities.

TABLE 1. CREDIT REQUIREMENTS FOR UNDER GRADUATE STUDIES

Program Core (PC)		Program Elective (PE)	
Category	Credit	Category	Credit
Departmental Core (DC)	79-82	Departmental Electives (DE)	33-48
1st year credits	39	Other Courses (OC)	0-6
		HM	0-6
Grand Total DC + DE			170

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 Lectures, 1 Tutorial and 0 Practical in a week. This subject will have eight credits ($3x2 + 1x1 + 0x1 = 8$). If a student is declared pass in a subject, then

he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a Grade. Each grade has got certain grade points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. SGPA and CGPA are:

$$SGPA = \frac{\sum_{semester}(Course\ credits \times Grade\ points)\ for\ all\ courses\ except\ audit}{\sum_{semester}(Course\ credits)for\ all\ courses\ except\ audit}$$

$$CGPA = \frac{\sum_{Allsemester}(Course\ credits \times Gradepoints)\ for\ all\ courses\ with\ pass\ grade\ except\ audit}{\sum_{Allsemester}(Course\ credits)for\ all\ courses\ except\ audit}$$

Students can Audit a few subjects. i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Details about Faculty members of Civil Engineering Department

Name of Faculty Member	Designation	Qualifications	Areas of specialization
Mhaisalkar V.A.	Professor	B.E, M.Tech, Ph.D	Environmental Engg
Gupta R.	Professor	B. E, M.Tech, Ph.D.	Environmental Engg.
Katpatal Y.B.	Professor	B.Sc, M.Tech, MBA, Ph.D	Remote Sensing and GIS
Tembhurkar A.R.	Professor	B.E, M.Tech, Ph.D	Environmental Engg
Ghare A.D.	Professor	B.E, M.Tech, Ph.D	Hydraulic Engg
Latkar M.V.	Associate Professor	B.Sc., M.Sc, Ph.D	Environmental Biochemistry
Lataye D.H.	Associate Professor	B.E, M.Tech , Ph.D	Environmental Engg
Ralegaonkar R.V.	Associate Professor	B.E, M.E, Ph.D	Energy Efficient Building, Disaster Management, Construction Technology & Management.
Landge V.S.	Associate Professor	B. E., M.E, Ph.D	Traffic Engineering
Mandal A.	Associate Professor	B. E., M.E, Ph.D	Soil Mechanics and Foundation Engg.
Vasudeo A.D.	Assistant Professor	B.E, M.Tech, Ph.D	Water Resources Engg.
Patel A.	Assistant Professor	B.E, M.Tech, Ph.D	Soil Mechanics and Foundation Engg.
Dongre S.R.	Assistant Professor	B.E., M.Tech, Ph.D	Environmental Engg.
Wanjari S. P.	Assistant Professor	B.E., M.Tech, Ph.D	Construction Technology and Management, Concrete Technology
Tawalare A.G.	Assistant Professor	B.E., M.Tech.	Structural Engg., Construction Technology & Mgt.
Mirajkar A.B.	Assistant Professor	B.E, M.E, Ph.D	Water Resources Engg.
Madurwar M.	Assistant Professor	B.E, M.E, Ph.D	Building Materials
Adhikary S.	Assistant Professor	B.E, M.Tech, Ph.D	Soil Dynamics

Programme Educational Objectives (PEOs)

The Civil Engineering program will produce graduates that, within a few years of graduation, will

1. Actively engage in problem solving using engineering principles to address the evolving needs of the society
2. Be able to succeed in positions in civil engineering practice or research, and in other fields they choose to pursue and enroll in advanced studies
3. Make ethical decisions and demonstrate a commitment to service to the profession and society.
4. Acquire a position or degree that values adaptability and innovation in their work.
5. Pursue lifelong learning, and to be leaders, both in their chosen profession and in other activities.

Program Outcomes (PO)

The program outcomes are as follows. Parameters on which the PO's of the program are based are given as below and aim of PO's is to enable students to:

a. Work in Civil Engineering sector which is involved with various aspects of planning, design, construction and operation of structures and systems.
b. Design and analysis of the complex problems and provide state of the art solutions.
c. Contribute to the academic and research in the broad field of civil engineering.
d. Develop knowledge and skills in the area of broad domain of civil engineering including construction technology, water resources, environmental engineering, geotechnical engineering, geospatial technology and transportation engineering.

Program outcomes adopted for correlation to course outcomes.

Graduates Attributes (GA's) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The GA's are indicators of the attributes expected of a graduate from an accredited program. The Graduates of this program must acquire:

a. An ability to apply knowledge of mathematics, science, and engineering to solve Civil engineering problems
b. An ability to identify, formulate, design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, safety, and sustainability
d. An ability to understand engineering and management functions and to be able to function on multidisciplinary teams
e. An ability to identify, formulate, and solve civil engineering problems
f. An understanding of professional and ethical responsibility to extend the social benefit of the civil engineering project
g. An ability to communicate effectively to handle complex engineering activities with the engineering community and the society at large, and should posses the skill of technical writing and effective presentation.
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, and societal context
i. A recognition of the need for and an ability to engage in independent life-long learning to incorporate technological innovations
j. A knowledge of contemporary issues and environment,
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

SCHEME FOR B.TECH IN CIVIL ENGINEERING

FOR BATCHES 2015 ONWARDS

Program Core(PC)		Program Elective (PE)	
Category	Credits	Category	Credits
Departmental Core(DC)	80	Departmental Elective (DE)	44-50
1st Year credits	43		
Grand total PC+PE			170

III Semester				IV Semester			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
CORE (DC)				**CORE (DC)**			
AML262	Mechanics of Solids	3-0-0	3	CEL210	Environmental Engineering I	3-0-0	3
AMP 262	Mechanics of Solids*	0-0-2	1	CEP 210	Environmental Engineering I*	0-0-2	1
CEL 201	Soil Mechanics	3-0-0	3	CEL211	Surveying II	3-0-0	3
CEP 201	Soil Mechanics*	0-0-2	1	CEP 211	Surveying II*	0-0-2	1
CEL 204	Building Materials and Technology	3-0-0	3	CEL215	Building Design and Drawing	2-1-0	3
CEP 204	Building Materials and Technology*	0-0-2	1	CEL213	Engineering Geology	3-0-0	3
CEL 207	Surveying I	3-0-0	3	CEP 213	Engineering Geology*	0-0-2	1
CEP 207	Surveying I*	0-0-2	1	CEL214	Hydraulic Engineering	3-0-0	3
				CEP 214	Hydraulic Engineering*	0-0-2	1
	Total Core Credits		**16**		**Total Core Credits**		**19**
ELECTIVE (DE)				**ELECTIVE (DE)(Any One)**			
CEL 208	Hydrology	3-0-0	3	CEL 209	Construction Materials	3-0-0	3
MAL 203	Numerical Methods and Computation	3-1-0	4	CEL 212	Rural Water Supply and Sanitation	3-0-0	3
				AML 364	Advanced Mechanics of Solids	3-0-0	3
			6				**3**
OPEN COURSES (OC)				**OPEN COURSES (OC)**			
CEL 220	Environmental Studies	3-0-0	3				
	4 DC + 2DE / OC = 22Credits				**5 DC + 1 DE/ OC/HM = 22Credits**		

V Semester				VI Semester			
CORE (DC)				**CORE (DC)**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
AML361	Structural Analysis	3-0-0	3	CEL305	Design of RCC Structures	3-1-0	4
AMP361	Structural Analysis*[*]	0-0-2	1	CEL314	Estimating and Costing	3-0-0	3
CEL 303	Environmental Engineering II	3-1-0	4	CEP314	Estimating and Costing*	0-0-2	1
CEL 312	Transportation Engineering	3-0-0	3	AML363	Design of Steel Structures	3-1-0	4
CEP 312	Transportation Engineering*	0-0-2	1	CEL301	Foundation Engineering	3-0-0	3
CEL 313	Concrete Engineering	3-0-0	3				
CEP 313	Concrete Engineering*	0-0-2	1				
	Total		**16**		Total		**16**
ELECTIVE (Any Two)				**ELECTIVE (Any two)**			
CEL 315	Fluid Mechanics	3-0-0	3	CEL 368	Advanced Hydraulics	3-1-0	4
CEP 315	Fluid Mechanics*	0-0-2	1	CEL 435	Remote Sensing and Geographical Information System	3-1-0	4
CEL 417	Disaster Management	3-0-0	3	CEL 311	Pavement Design	3-0-0	3
CEL 423	Introduction to Soil Dynamics	3-0-0	3	AML462	Elements of Structural Dynamics and Earthquake Engineering	3-0-0	3
CEL 404	Railway, Airports, Ports and Harbor Engineering	3-0-0	3				
AML 365	Design of Masonry Structures	3-0-0	3				
OC/HM				**OC/HM**			
4 DC + 2 DE/ OC/HM =22/23 Credits				**4 DC + 2 DE/ OC/HM = 22/23Credits**			
VII Semester				**VIII Semester**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
CORE				**CORE**			
CED401	Project Phase I	0-0-4	2	CEL401	Irrigation Engineering	3-1-0	4
CEL307	Project Planning and Management	3-1-0	4	CED402	Project Phase II		4
	Total		6		**Total**		8
ELECTIVE				**ELECTIVE**			
AML461	Advanced Structural Analysis	3-1-0	4	CEL 425	Financial and Business Management	3-0-0	3
CEL413	Pre-stressed Concrete Structures	3-1-0	4	AML525	Design of Advanced Steel Structure	3-1-0	4
AML424	Structural Dynamics	3-0-0	3	CEL414	Water Distribution Systems	3-1-0	4
CEL409	Quality and Safety in Construction	3-0-0	3	AML467	Advanced RCC	3-1-0	4
CEL 552	Construction Contracts and Specifications	3-0-0	3	CEL 441	Geotechnical Aspects for Design of Machine Foundation	3-1-0	4
CEL 442	Geotechnical Investigation for Construction Projects	3-0-0	3	CEL 415	Advanced Structural Design	3-1-0	4
CEL 419	River Engineering	3-0-0	3	AML469	Basics of Finite Element Methods	3-0-0	3
CEL 422	Hazardous Waste Management	3-0-0	3				
CEL 436	Computer Aided Design and Analysis*	3-0-0	3				
CEP436	Computer Aided Design and Analysis*	0-0-2	1				
CEL 423	Introduction to Soil Dynamics	3-0-0	3				
CEL 408	Construction Site Administration and Control	3-0-0	3				
CEL 429	Hydraulic Transients	3-0-0	3				
AML 468	Maintenance and Rehabilitation of Civil Engineering Structures	3-0-0	3				

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[*] Student must register both for practical and theory of a course

SCHEME FOR B.TECH IN CIVIL ENGINEERING
(Batch 2014 and Earlier)

Undergraduate Core (DC)		Undergraduate Elective (DE)	
Category	**Credit**	**Category**	**Credit**
Departmental Core (DC)	146-152	Departmental Electives (DE)	60-96
Basic Science (BS)	32	Other Courses (OC)	0-12
Engineering Sciences(ES)	36		
HM	0-6		
Total	214-226	Total	60-108
Grand Total DC + DE			320

I Semester				II Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
ELECTIVE				**ELECTIVE**			
Total				**Total**			
III Semester				IV Semester			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
CORE (DC)				**CORE (DC)**			
AML262	Mechanics of Solids	3-0-0	6	CEL210	Environmental Engineering I	3-0-0	6
AMP 262	Mechanics of Solids	0-0-2	2	CEP 210	Environmental Engineering I	0-0-2	2
CEL 201	Soil Mechanics	3-0-0	6	CEL211	Surveying II	3-0-0	6
CEP 201	Soil Mechanics	0-0-2	2	CEP 211	Surveying II	0-0-2	2
CEL 204	Building Materials and Technology	3-0-0	6	CEL215	Building Design and Drawing	2-0-0	4
CEP 204	Building Materials and Technology	0-0-2	2	CEP215	Building Design and Drawing	0-0-2	2
CEL 207	Surveying I	3-0-0	6	CEL213	Engineering Geology	3-0-0	6
CEP 207	Surveying I	0-0-2	2	CEP 213	Engineering Geology	0-0-2	2
				CEL214	Hydraulic Engineering	3-0-0	6
				CEP 214	Hydraulic Engineering	0-0-2	2
	Total Core Credits		**32**		**Total Core Credits**		38
ELECTIVE (DE)				**ELECTIVE (DE)**			
CEL 208	Hydrology	3-0-0	6	CEL 209	Construction Materials	3-0-0	6
MAL 203	Numerical Methods and Computation	3-0-0	6	CEL 212	Rural Water Supply and Sanitation	3-0-0	6
				AML 364	Advanced Mechanics of Solids	3-0-0	6
OPEN COURSES (OC)				**OPEN COURSES (OC)**			
CEL 220	Environmental Studies	3-0-0	6				
	4 DC + 1 DE + 1 OC = 44 Credits		**44**		**5 DC + 1 DE/ OC/HM = 44 Credits**		

V Semester				VI Semester			
CORE (DC)				**CORE (DC)**			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
AML361	Structural Analysis	3-0-0	6	CEL305	Design of RCC Structures	3-0-0	6
AMP 361	Structural Analysis	0-0-2	2	CEL314	Estimating and Costing	3-0-0	6
CEL 303	Environmental Engineering II	3-0-0	6	CEP314	Estimating and Costing	0-0-2	2
CEL 312	Transportation Engineering	3-0-0	6	AML 363	Design of Steel Structures	3-0-0	6
CEP 312	Transportation Engineering	0-0-2	2	CEL301	Foundation Engineering	3-0-0	6
CEL 313	Concrete Engineering	3-0-0	6				
CEP 313	Concrete Engineering	0-0-2	2				
	Total		**30**		**Total**		**26**
ELECTIVE (Any Two)				**ELECTIVE (Any two)**			
CEL 315	Fluid Mechanics	3-0-0	6	CEL 368	Advanced Hydraulics	3-1-0	8
CEP 315	Fluid Mechanics	0-0-2	2	CEL 435	Remote Sensing and Geographical Information System	3-1-0	8
CEL 417	Disaster Management	3-0-0	6	CEL 311	Pavement Design	3-1-0	8
CEL 404	Railway, Airports, Ports and Harbor Engineering	3-0-0	6	AML462	Elements of Structural Dynamics and Earthquake Engineering	3-0-0	6
CEL 423	Introduction to Soil Dynamics	3-0-0	6				
AML 365	Design of Masonry Structures	3-0-0	6				
OC/HM				**OC/HM**			
4 DC + 2 DE/ OC/HM = 42+ Credits		**42+**		4 DC + 2 DE/ OC/HM = 40+ Credits		**40+**	

VII Semester				VIII Semester			
Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
CORE				**CORE**			
CED401	Project Phase I	0-0-4	4	CEL401	Irrigation Engineering	3-1-0	8
CEL307	Project Planning and Management	3-0-0	6	CED402	Project Phase II		8
	Total		**10**		**Total**		**16**
ELECTIVE				**ELECTIVE**			
AML461	Advanced Structural Analysis	3-1-0	8	CEL 425	Financial and Business Management	3-0-0	6
CEL413	Pre-stressed Concrete Structures	3-1-0	8	AML525	Design of Advanced Steel Structure	3-1-0	8
AML424	Structural Dynamics	3-0-0	6	CEL414	Water Distribution Systems	3-1-0	8
CEL409	Quality and Safety in Construction	3-0-0	6	AML467	Advanced RCC	3-1-0	8
CEL552	Construction Contracts and Specifications	3-0-0	6	CEL 441	Geotechnical Aspects in Design of Machine Foundation	3-1-0	8
CEL442	Geotechnical Investigation for Construction Projects	3-0-0	6	CEL 415	Advanced Structural Design	3-1-0	8
CEL419	River Engineering	3-0-0	6	AML469	Basics of Finite Element Methods	3-0-0	6
CEL422	Hazardous Waste Management	3-0-0	6				
CEL436	Computer Aided Design and Analysis	3-0-0	6				
CEP436	Computer Aided Design and Analysis	0-0-2	2				
CEL423	Introduction to Soil Dynamics	3-0-0	6				
CEL408	Construction Site Administration and Control	3-0-0	6				
CEL 429	Hydraulic Transients	3-0-0	6				
AML 468	Maintenance and Rehabilitation of Civil Engineering Structures	3-0-0	6				
	1 DC + 1 Project + 5 DE/ OC/HM = 40+ Credits		**40+**		1 Project+ 1 DC + 3 DE/ OC/HM = 32+ Credits		**32+**

CEL 201 – SOIL MECHANICS   [(3-0-0); Credits: 3]

Course Objectives:
1. Introduction of formation of soil.
2. Different soil Properties and co-relation.
3. Behavior of soil under external load.
4. Determination and physical understanding of soil parameters.

Syllabus:
Introduction: Formation of soil, residual and transported soils, soil, generally used in practice such as sand, gravel, organic silt, clay, Bentonite, black cotton soil etc.

Phases of Soil: Various soil weight and volume inter-relationship, Density index, Methods of determination of in situ density, Physical and Index Properties of soil- concept and methods determination. Water content, specific gravity, sieve analysis, particle size distribution curve, sedimentation analysis, Differential and free-swell value, Consistency of Soil – Atterberg's limits determination, Soil structures and clay minerals.

Classification of Soil: Criteria of classification, particle size classification, Textural classification, Unified and I.S. classification system, Field identification of Expansive soils their identification and related problems.

Permeability and Seepage: Darcy's law and its validity, Discharge and seepage velocity, factors affecting permeability, Determination of coefficients of permeability by laboratory and field methods, permeability of stratified soil, Seepage pressure, quick condition, flow-nets, Laplace's equation, methods to draw flow-nets, their characteristics and uses of flow-nets, Preliminary problems of discharge estimation of homogeneous soils. Effective, Neural and total stresses in Soil mass.

Stress Distribution: Stress distribution in soil mass, Boussinesque's, Theory point and uniformly loaded rectangular and circular areas, Newark's charts.

Consolidation: Compression of laterally confined soil, Terzaghie's 1-D consolidation theory (formation of differential equation only) determination of coefficient of consolidation, degree of consolidation. Determination of pre-consolidation pressure, settlement and rate of settlement.

Compaction: Mechanics of compaction factors affecting compaction, standard and modified compaction tests, OMC, Field compaction equipment, quality control, Concept of blending.

Shear Strength: Introduction, Mohr's diagram, Mohr-Coloumb's theory, Measurement of shear strength by direct shear test, tri-axial test, unconfined compression test, vane shear test, and sensitivity.

Shear Strength: Introduction, Mohr's diagram, Mohr-Coloumb's theory, Measurement of   shear strength by direct shear test, tri-axial test, unconfined compression test, vane shear test, and sensitivity.

Course Outcomes:
1. Gain a broad understanding of mechanics of soil
2. Get accustoms with the measurement of different soil parameters.
3. Determination of shear strength and permeability of soil as suitable construction material.
4. Contemporary issues and developments.

REFERRENCE:
1. Alam Singh. "Soil Engineering in Theory and Practice" Asia Publishing House 1975
2. S. K. GulhatiandManoj Dutta: Geotechnical Engineering, Tata McGraw-Hill, 2005.
3. Gopal Ranjanand A.S. Rao "Basic and Applied Soil Mechanics" New Age International Ltd, 2004.
4. C. Venkatramaiah Geotechnical Engineering New Age Ltd., 2006.

5. Arora K.R. Soil Mechanics and Foundation Engg. Standard Publishers Distributors, Delhi, 1989 and later.
6. Garg S.K. Soil Mechanics and Foundation Engg. Khanna Publishers, Delhi, 1998.
7. Punrnia B.C. Soil Mechanics and Foundation Engg. Laxmi Publication Pvt. Ltd, New Delhi, 2005.

CEP 201 – SOIL MECHANICS   **[(0-0-2); Credits: 1]**

1. Grain size Distribution-(Mechanical Method)
2. Liquid Limit and Plastic Limit Test
3. In-Place Density Test
4. Specific Gravity Test
5. Permeability Test-Variable Head, Constant head
6. Specific Gravity Test
7. Compaction Test
8. Unconfined Compression Test
9. Direct Shear Test.

CEL 214 - HYDRAULIC ENGINEERING   **[(3-0-0); Credits: 3]**

Course Objectives:

1. Introduce to Fluid state of matter.
2. Making students understand the importance of Fluid and its flow.
3. To make student explore the various equations and the concepts related fluid motion and equilibrium.
4. To make students understand the correlation between theory and practical by making them do practical's which are physical simulations of the theory such as Bernoulli's equation, venturimeter, orifices etc..

Syllabus:

Fluid Properties and measurement of pressure – manometers and gauges, Hydrostatics- Total pressure and centre of pressure, pressure forces on vertical and inclined laminae, pressure on curved surfaces, Buoyancy and floatation – Centre of buoyancy, body immersed in two different fluids, metacentre, metacentric height, stable, unstable and neutral equilibrium

Types of fluid flows and flow lines, Methods of describing fluid motion, Fundamental equations of fluid flow, Venturimeter, Orifice and mouthpiece, Notches and weirs

Elements of flow through pipes: Darcy Weisbach formula, Hydraulic Gradient Line, Total Energy Line, Minor losses, series and parallel connections

Introduction to open channel flow: Manning's and Chezy's formula, Most economical section of channel, Uniform flow and Critical flow, Hydraulic jump elements.

Impact of Jet, Types of hydraulic turbines, Introduction to Centrifugal and Reciprocating pumps.

REFERRENCE:

1. Garde R.J. and Mirajgaokar A.G.; Engineering Fluid Mechanics, Scitech Publication, 2003.
2. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publication, 1996.
3. Streeter V.L. and Wyle E.B.; Fluid Mechanics;, International Students Edition 1986.
4. Modi S.M. and Seth S.M.; Hydraulics and Fluid Mechanics including Hydraulic Machines; PHI learning Pvt. Ltd. 2015
5. Som S.K., Gautam Biswas and Suman Chakraborty; Introduction to Fluid Mechanics and Fluid Machines, Mc Graw Hill Education 2011.

CEP 214 - HYDRAULIC ENGINEERING   [(0-0-2); Credits: 1]

1. Ship model
2. Triangular notch
3. Rectangular notch
4. Orifice
5. Mouthpiece
6. Manometers and pressure gauges
7. Pitot tube
8. Friction factor of pipeline
9. Chezy's and Manning's constant for a channel
10. Venturimeter.

CEL 210 – ENVIRONMENTAL ENGINEERING I [(3-0-0); Credits: 3]

Course Objectives:
1. To learn the fundamentals of Water Engineering
2. To understand various components of water supply scheme
3. To build skills to quantitative and qualitative assessment of water requirement
4. To understand how to solve water treatment unit design problems using hydraulic principles and methods
5. To understand operation of water treatment units.
6. To provide broad knowledge of solid waste management systems.

Syllabus:

Importance and necessity of water supply scheme; planning of WSS; design period; population forecasting; water demand; sources of surface water, ground water, intake structure; conveyance of water, types of pipe joints and fitting; hydraulic design of pipes, rising main; pumps; water quality, standards of drinking water, Theory and application of water treatment unit operation and processes, aeration, coagulation, flocculation, sedimentation, filtration, disinfection; Selection of site and processes of water treatment, treatment flowsheet; Distribution system, appurtenances, detection and prevention of leakage, storage reservoir for treated water. Introduction to solid waste management,

Course Outcomes:
1. Understand the water supply scheme and be able to estimate quantities and quality of water for municipal use
2. Understand the types of processes used to treat water for municipal purpose
3. Understand how processes are configured in treatment systems.
4. Understand the fundamental engineering and science principles that are used to design and operate the processes used in treatment systems.
5. Learn how to use laboratory procedures and measurements to determine qualitative parameter of water and wastewater.
6. Understand basics of solid waste management.

REFERRENCE:
1. B.C. Punmia, A.K Jain, Environmental Engineering I - Water Supply Engineering – Laxmi Publication Pvt. Ltd
2. S.K. Garg, Environmental Engineering –I, Standard Publication Pvt. Ltd.
3. Metcalf, Eddy, "Wastewater Engineering"- McGraw Hill Publication.
4. M.J. Macghee, "Water Supply and Sewage – McGraw Hill Publication

CEP 210 – ENVIRONMENTAL ENGINEERING I   [(0-0-2); Credits: 1]

1. Determination of pH
2. Determination of conductivity
3. Determination of chlorides
4. Determination of Solids
5. Determination of turbidity
6. Determination of Acidity and alkalinity
7. Determination of dissolved oxygen
8. Determination of hardness
9. Determination of available chlorine
10. Jar test
11. Bacteriological plate count and MPN
12. Demonstration of COD, BOD

CEL 204 – BUILDING MATERIALS AND TECHNOLOGY   **[(3-0-0); Credits: 3]**

Course Objectives:

1. To retrieve various components of building, interpret their functions and methods of construction along with fundamentals of design.

Syllabus:

Foundations: necessity and types of foundations, details of shallow foundations, bearing capacity of soils and its assessment, loads on foundations, causes of failures of foundations and remedial measures, foundation on black cotton soil, setting out foundation trenches, excavation, timbering of trenches.

Brickwork: constituents of brick earth, manufacturing, types, IS Classification of bricks, specification of mortar for brick masonry, commonly used types of bonds in brickwork, principles of construction, common defects in brick masonry, brick knogging, parapets, copings, sills and corbels, masonry construction using cement concrete blocks (solid & hollow) and clay blocks, reinforced brickwork, walls - cavity walls, load bearing and partition walls.

Stone work: common building stones in India, selection of stones, quarrying and dressing of stones, lifting appliances for heavy stones, types of stone masonry, principles of construction, joints in masonry, specification of mortar for stone masonry.

Arches and lintels: terminology in construction, types, chajjas and canopies, precast lintels & arches, Damp proofing: causes and effect of dampness, methods of damp proofing, materials used including new materials like epoxy, resins etc., techniques of damp proofing.

Floors and roofs: components, materials, types and method of construction, tiled flooring such as ceramic tiles, terracotta, introduction to upper floor, flat and pitched roofs, roof coverings, types and their constructional features, thermal insulation of roofs.

Stairs: Terminologies in stairs, types of stairs, functional design of stairs, Doors & windows: purpose, materials of construction and types.

Plastering & pointing: necessity, mortars used, methods of plastering, types of finishes, types of pointing, Temporary timbering: centering and formwork, shoring, underpinning and scaffolding, painting: white washing, color washing and distempering, new materials & techniques, principle of acoustics, and sound insulation, introduction to principles of earthquake resistant buildings.

Course Outcome:
1. Understand the importance and role of each component in building.
2. Apply basic fundamentals of design and construction for any building.
3. Select construction materials under different site conditions by understanding the basic properties of materials.
4. Supervise the construction work of buildings.

REFERRENCE:
1. Singh Gurcharan, Building Construction and Materials, Standard Publisher and Distributor, 1978 New.
2. Punmia B.C., Building Construction and Materials, Laxmi Publication Pvt. Ltd Fifth.
3. Sushil Kumar, Building Construction and Materials, Standard Publisher and Distributor, 2003 reprint

CEP 204 – BUILDING MATERIALS and TECHNOLOGY   [(0-0-2); Credits: 1]

Course Objective:

To test the physical properties of different construction materials as per the standard procedures lay down by I.S. codes.

1. To perform dimension test on burnt clay building bricks
2. To determine water absorption of burnt clay building bricks.
3. To determine Efflorescence of burnt clay building bricks.
4. To determine crushing strength of burnt clay building bricks.
5. To determine water absorption of cement concrete/terrazzo flooring tiles.
6. To determine flexural/transverse strength of cement concrete flooring tiles.
7. To test resistance of cement concrete flooring tiles against wear.
8. To determine water absorption of Mangalore roofing tiles.
9. To determine breaking load of roofing tiles.
10. To determine moisture content and specific gravity of timber.
11. To determine compressive strength of timber specimen in parallel and perpendicular to grains direction.
12. To determine impact value of white glazed ceramic tiles.

CEL 215 –BUILDING DESIGN AND DRAWING   **[(2-1-0); Credits: 3]**

Course Objectives:

1. To design and plan the residential buildings as per local bye-laws and produce different types of drawings for the same.

Syllabus:
Importance of building drawing as engineer's language in construction & costing.

Selection of scales for various drawings, thickness of lines, dimensioning, combined first angle and third angle methods of projection, abbreviations and conventional representations as per IS: 962, 1989, free hand dimensioned sketches of various building elements and their importance in civil engineering.

Developing working drawing to scale as per IS 962 from the given line plan, design and general specifications for different components of the building including terraced and pitched roofs, developing submission drawings to scale with location plan, site plan and block plan.

Functional planning of residential buildings, principles of site selection, types of residential buildings, design requirements of residential areas, planning regulations and building bye-laws, principals of planning, functional planning of public buildings, factors affecting site selection, design aspects for different public buildings, recommendations of CBRI, Roorkee.

Graph paper drawings (line plans) for residential, public, educational, industrial buildings based on various requirements and interior aspects.

Two point perspective of residential building neglecting small elements of building such as plinth offset, chajja projections etc.

1. Working drawing of single storied residential building of terrace and pitched roofs with foundation plan of load bearing structure. (Two assignment)
2. Submission drawing of single storied residential building (framed structure) with access to terrace including all details and statements as per the local bye-laws. (One assignment A1 sheet)
3. Working drawing of multistoried Public / Educational/ Health / Community / Industrial building including structural details and layout of services. (One assignments)
4. Two point perspective of the single storied Residential building neglecting small building elements. (Two assignments – pitched & terrace roof)
5. Minimum 30 free hand self-explanatory dimensioned sketches of various building elements in sketch book.
6. Line plans of various types of buildings e.g. Public / Educational / Industrial / Hospital / Community on graph papers (04 assignments)
7. One compulsory field exercise.

Course Outcome:

1. Gain a broad understanding of planning and designing of buildings
2. Develop working and submission drawings for any building
3. Know the procedures of submission of drawings and getting sanctions for a project
4. Plan and design a residential or public building as per the given requirements
5. Develop the perspective views for any building.

REFERENCE:

1. Building Drawing with an integrated approach to built environment by Shah, Kale & Patki, Tata McGraw Hill Publishing Co. Ltd.
2. A course in Civil Engg. Drawing by V. B. Sikka, S. K. Katarian and sons, Fifth Edn.
3. Civil Engineering Drawing by Malik and Meo, New Asian Publishers, Fifth Edn.
4. IS: 962-1989 (Code of practice for architectural and building drawing)
5. Time Saver Standard by Dodge F. W., F. W. Dodge Corp., Third Edn.

CEL 213–ENGINEERING GEOLOGY [(3-0-0); Credits: 3]

Course Objectives:
1. To Understand the Earth System
2. Teach fundamental geomorphic and dynamic processes on the Earth
3. To know about the material present i.e. minerals and rocks
4. Understand Structural deformations and impacts
5. Earthquakes and causes, effects, zones
6. Know subsurface exploration methods
7. Know groundwater availability and domains; recharge
8. Teach consideration for site selection for projects.

Syllabus:

Geodynamics: Internal structure of the earth, Continental drift and Plate Tectonics. Geomorphology: Geomorphological processes and classification, weathering and erosion, landforms.

Mineralogy: Definition and classification of Minerals, Megascopic physical properties of Minerals, Overview of silicate family minerals (Quartz, Feldspar, Olivine, Pyroxene, Amphibole, Mica).

Petrology: Rock cycle; Genesis, Textures, Forms/structures, classification and strength aspects of Igneous, sedimentary and Metamorphic rocks. Geomechanical properties of rocks, Rock as construction aggregate and road metal.

Structural Geology: Rock Deformation; Attitude of rocks, Mechanism of formation, nomenclature classification and field identification of Folds, Joints, Faults. Problems on Strike, Dip, thickness and depth of strata.

Stratigraphy: Scope & application of Stratigraphic principles, overview of Indian Stratigraphy.

Introduction to Rock Mechanics: Concept of stress and strain in rocks, rock mass classification and rating, RQD, etc. Surface and subsurface geological investigations; Drilling, core logging, Geological, geophysical and remote sensing investigations; Scope of rock excavation, blasting techniques, Geological criteria for design & construction of Dams, Bridges, Tunnels, buildings.

Mass movements, Stability of Slopes & Landslides: Causes and prevention.

Engineering Seismology: Causes and effects of earthquakes; Seismic waves, magnitude, intensity, seismic zoning & seismic Zones of India; Tsunamis.

Geohydrology: Rocks as aquifers, occurrence and availability of Groundwater; Groundwater investigations, groundwater development and management in India; Techniques of groundwater recharge.

Course Outcomes:
1. Generate global vision of Earth process
2. Identify the subsurface material.
3. Knows reason for phenomena like Earthquakes and zoning.
4. Know about ground water availability zones and ground water management.
5. Know megascopic and mechanical properties of rocks.
6. Know field procedures of subsurface exploration.
7. Generate subsurface profiles and map structures.
8. Know considerations for site selection for engineering projects.

REFERRENCE:
1. KVGK Gokhale, Principles of Engineering Geology, BS Publications.
2. F. G. Bell, Fundamentals of Engineering Geology, BS Publications, 2005.
3. Parbin Singh, Engineering Geology, S K Kataria and Sons, Sixth Edition.
4. Homes Arthur and Homles Doris, Principles of Physical Geology, ElBS Publications, 1987.
5. F.G. H. Blythand M.H. de Freitas, A geology for Engineers, Elsevier, Seventh Edition.

CEP 213–ENGINEERING GEOLOGY   **[(0-0-2); Credits: 1]**

1. Megascopic study of Minerals and Rocks
2. Geological maps and Profiles
3. Three point and Dip Strike problems
4. Electrical Resistivity Survey
5. Groundwater availability is aquifers
6. Rock Mass rating problem

CEL 207-SURVEYING I [(3-0-0); Credits: 3]

Course Objectives:
1. Principal and rule of Surveying.
2. Different Surveying method and related Instrument.
3. Use of field book for different Survey.
4. Use of with different survey equipment.

Syllabus:
Linear Measurements: Methods, Equipments, Ranging, Chain Surveying, Field Work and Plotting, Obstacles in Chaining, area and Volume Computation
Compass Surveying: Instrument, Principles, Bearings
Plane Table: Equipment, Methods, Errors, Adjustment Survey, Traversing and Plotting
Leveling: Instruments, Collimation Method, Rise-Fall Method, Curvature and Refraction, Contouring
Theodolite survey: Study of theodolite, Temporary and permanent adjustments, Measurement of horizontal angles, Methods of repetition and reiteration, Measurement of vertical angles.
Tachometric Surveying: Theory, Instrument Constants, Methods

Course Outcome:
1. Gain a broad understanding of Land Survey
2. Get accustoms with the angular and linear measurements.
3. Trained with recording the field information and necessary plot.
4. Contemporary issues and developments.

REFERRENCE:
1. B. C. Punmia, Standard Book-House Latest
2. S. K Duggal, Surveying Volume I, Tata McGraw Hill, Latest.
3. A. M Chandra, Plane Surveying, New Age International Publication.

CEP 207-SURVEYING I   [(0-0-2); Credits: 1]

1. Chain survey Traversing and plotting of details-Area Determination.
2. Building lay- out work.
3. Plane table survey Method of Radiation/ Intersection.
4. Plane table survey solving two/ three point problem.
5. Plane table survey Traverse.
6. Instrument Constant-Tachometer.
7. Leveling Fly leveling – Plane of collimation method.
8. Leveling Fly leveling – Rise and fall method.
9. Theodolite surveying Measurement of horizontal angle.
10. Theodolite surveying Measurement of vertical angle for determination of height of object.

CEL 208-HYDROLOGY [(3-0-0); Credits: 3]

Course Objectives:
1. Introduction to Hydrology.
2. Making students understand the importance of Water Resources.
3. To expose the students to the various components of the water cycle and their importance.
4. Teach data analysis using various techniques and implementation of the results.

Syllabus:

Introduction: Hydrological cycle, Precipitation- forms and types.

Abstractions: Infiltration, Evaporation, Transpiration, Evapotranspiration, Interception.

Runoff: Sources and components of runoff, Classification of streams and measurement of discharge of a stream by Area – Slope and Area – Velocity methods.

Hydrograph: Flood hydrographs and its components, S-Curve technique, unit hydrograph, synthetic hydrograph. Statistical Methods, Various methods of averages, probability of an event, Frequency analysis.

Floods: Causes and effects, Factors affecting peak flows and its estimation, Flood routing and Flood forecasting.

Groundwater: Introduction, Occurrence and distribution of Groundwater, Water table, Darcy's law. Introduction to hydraulics of wells, Open wells - yield test.

Course Outcome:
1. Gain broad understanding of hydrology.
2. Get to know about different hydrographs and statistical methods.
3. Understand various components of water cycle and their importance.
4. Know various data analysis techniques and its implementation.

REFERRENCE:
1. M. J. Deodhar, Elementary Engineering Hydrology, Pearson Education 2009.
2. Raghunath H M, Hydrology Wylie Publication 1996.
3. Chow VenTe, Maidment R David, Mays W Larry, Applied Hydrology, McGraw-Hill New Delhi, 1998.

CEL 209-CONSTRUCTION MATERIALS   **[(3-0-0); Credits: 3]**

Course Objectives:
1. Introduction to various masonry units, classification and properties.
2. Introduction to different types of mortars and concrete and the factors affecting strength and suitability.
3. Introduction to timber and its various characteristics.
4. To know the recent advancement in building material and their effect on environment.
5. To understand different types of masonries and their applications

Syllabus:
Masonry units - Building stones, classification of rocks, common building stones and their properties, qualities of good building stones, criterion of selection, quarrying, methods of quarrying, deterioration and preservation of stones, Composition of brick earth, manufacturing of bricks, classification, special types of bricks, other clay and ceramic products, clay tiles, manufacturing process, types.

Mortars and Concrete – limes, classification and slaking of lime, manufacturing of cement, types of cements, sources of sand, classification and characteristics of sand for mortars and plasters, types of mortars, preparation of mortars, properties, factors affecting their strength, concrete types and their suitability.

Timber – classification of trees, structure of a timber tree, characteristics of good timber, defects in timber, decay, seasoning of timber, methods, preservation of timber, characteristics of other timber products such as plywood, particle board, hardboard etc. and their uses.

Glass manufacturing, classification and uses, glass wool, plastics, polymerization, classification, types and uses, ferrous, non-ferrous metals and alloys such steel, aluminum, copper, zinc etc., gypsum and allied products such as plaster of paris, paints, distempers and varnishes, rubber, adhesives and sealants, miscellaneous materials, recent advances in building materials, characteristics and their effect on environment.

Course Outcome:
1. To identify various building materials and select suitable type of building material.
2. To be aware of various traditional building materials and also the emerging materials in the field of Civil Engineering construction.
3. Understand different types of masonry and its applications.

REFERENCES
1. Building materials by P. C. Varghese, Prentice Hall of India Pvt. Ltd., New Delhi. (2006 Edn.)
2. Engineering materials by R. K. Rajput, S. Chand & Company Ltd. (2000 Edn.).
3. Building Construction by S. P. Arora and S. P. Bindra, Dhanpat Rai Publications Pvt Ltd. (2010 Edn.)
4. Building Construction by B. C. Punmia, Laxmi Publications Pvt. Ltd.
5. Building Construction by Sushil Kumar, Standard Publisher,

CEL 220 ENVIRONMENTAL STUDIES   **[(3-0-0); Credits: 3]**

Course Objectives:
1. Introduce to various natural resources, their importance and status.
2. Introduce to the concepts of ecosystem, their structure and functions.
3. Introduce to the concept of biodiversity conservation.
4. Introduce to possible causes of various forms of environmental pollution and their consequences, methods of prevention.
5. Introduce to various social and climatic changes due to pollution.

Syllabus:

Natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

Ecosystem: Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Ecological succession, Food chain, food webs and pyramids.

Biodiversity and its conservation: Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation.

Environmental pollution: Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes.

Social issues and environment: Sustainable development, Water conservation, Rain water harvesting, Watershed management, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accident, Holocaust, Environmental rules and regulations.

Human population and environment: Population growth, Environment and human health, Human rights, Value education, Role of information technology in environment and human health.

Course Outcome:
1. Understand various natural resources, their importance and status.
2. Understand the concepts of ecosystem, their structure and functions.
3. Understand the concept of biodiversity conservation.
4. Understand the causes of various forms of environmental pollution and their consequence, and methods of prevention.
5. Understand the various changes in social and climate due to pollution.

REFERRENCE:
1. Rajgopalan R., Environmental Studies.
2. Benny Joseph, Environmental Studies, McGraw Hill.
3. ErachBarucha Environmental Studies University press (UGC).

CEL 212 RURAL WATER SUPPLY AND SANITATION   [(3-0-0); Credits 3]

Course Objectives:
1. To introduce about various rural water supply programs in India
2. To introduce various rural water supply schemes
3. To introduce various rural sanitation programs in India
4. To introduce various low cost sanitation methods in India

Syllabus:
National Water Policy, Status of Rural water supply in India, National and State level programs of RWS, Planning and implementation of rural water supply, problem village Source development, springs, dug wells, infiltration wells etc. Package water treatment plants, appropriate technology for removal of excess iron and manganese, fluoride, arsenic for drinking water, surface water treatment, slow sand filtration, disinfection in RWS. Guidelines for Design of RWS, Types of RWS systems and their components, types of pipes, pumps used in RWS, Community participation in planning, design, O and M of RWS.

Low Cost Sanitation Methods, Centralised and Decentralised Methods of Rural Sanitation, Pit Privy, Aqua Privy, Water Seal Latrine, Bore-hole Latrine, bucket Latrine Feuill'ees or Trench Latrine, Overhung Latrine, Compost Privy, Chemical Toilet, Double Pit Latrine, Pour Flush Latrine, Improved Double Pit Pour Flush Latrine, Septic Tank, design of Septic Tank, disposal of Septic tank effluent. Water Carried Methods of Excreta Disposal for Rural Areas, Excreta Disposal Programs for Rural Areas Composting, Methods of Composting, Indore Method, Bangalore Method, NADEP Method, Vermicomposting Method, bio dung Vermicomposting, Gobar Gas Plant, Sulabh Sauchalaya. Role of NGO's and GO's in Rural Sanitation Community Participation in Rural Sanitation.

Course Outcome
1. Gain knowledge about various rural water supply programs in India.
2. Able to understand various water supply scheme, design of rural water supply schemes.
3. Able to understand about various rural sanitation schemes in India.
4. Gain knowledge about the methods of low cost sanitation.
5. Gain knowledge about the design of septic tank.

REFERRENCE:
1. E.G. Wagner and J.N. Lanoix, Excreta Disposal for Rural Areas and Small Communities.
2. B.C.Punmia Environmental Engineering – II, Laxmi Publication, 2002.
3. Garg S.K.; Environmental Engineering – II Standard Publication 2002.

CEL 301 FOUNDATION ENGINEERING [(3-0-0); Credits: 3]

Course Objectives:
1. Decision of choosing appropriate shear parameters for stability of slopes, assessment of earth pressures, foundation design & analysis.
2. Methods of stability analysis of slopes.
3. Various earth pressure theories
4. Design & analysis of shallow foundations
5. Deciding dimensions of piles & their load carrying capacity
6. Learn methods & process of Geotechnical Exploration
7. Introduction to Ground Improvement techniques.

Syllabus:

Shear Strength: General principle of tests, concept of failure strength, Drainage condition, pore pressure and its measurement, pore pressure parameters, Modified failure envelope. Liquefaction and effect of soil shaking, Shear Strength of cohesionless and cohesive soils.

Stability of Slopes: Causes and types of slope failure, stability analysis of infinite slopes and finite slopes, centre of critical slip circle, slices method for homogeneous c-φ soil, slopes with pore pressure consideration. Taylor's stability numbers and stability charts, methods of improving stability of slopes.

Lateral Earth Pressure: Earth pressure at rest, active and passive pressure, General and local states of plastic equilibrium in soil. Rankine's and Coulomb's theories for earth pressure. Effects of surcharge, and submergence. Rebhann's criteria for active earth pressure. Graphical construction by Culman for simple cases of wall-soil system for active pressure condition.

Ground Improvement: Methods of soil stabilization use of admixtures (lime, cement, fly-ash) in stabilization. Basic concepts of reinforced earth, use of geo-synthetic materials, Salient features, function and applications of various geo-synthetic materials.

Bearing capacity of soils: Terzaghi's theory, its validity and limitations, bearing capacity factors, types of shear failure in foundation soil, effect of water table on bearing capacity, correction factors for shape and depth of footings. Bearing capacity estimation from N-value, factors affecting bearing capacity, presumptive bearing capacity.

Settlement of shallow foundation: causes of settlement, elastic and consolidation settlement, differential settlement, control of excessive settlement. Proportioning of footings for equal settlement. Plate load test: Procedure, interpretation for bearing capacity and settlement prediction.

Pile Foundation: Classification of piles, constructional features of cast-in-situ and pre cast concrete piles. Pile driving methods, effect of the driving on ground. Load transfer mechanism of axially loaded piles. Pile capacity by static formula and dynamic formulae, pile load test and interpretation of data, group action in piles, spacing of piles in groups, group efficiency, overlapping of stresses. Settlement of pile group by simple approach, negative skin friction and its effect on pile capacity, general feature of under reamed piles.

Geotechnical Exploration: Importance and objectives of field exploration, principal methods of subsurface exploration, open pits and shafts, types of boring, number, location and depth of boring for different structures, type of soil samples and samplers. Principles of design of samplers, boring and sampling record. Standard penetration test, corrections to N-values and correlation for obtaining design soil parameters.

Course Outcome:
1. Choose appropriate shear parameters in various applications
2. Analysis stability of slopes

3. Decide exerted earth pressure on different structures
4. Determine and decide safe bearing capacity of soil
5. Able to design shallow and deep foundations
6. Plan & conduct Geotechnical Exploration Program
7. Able to select suitable ground improvement technique and implement it in field

REFERRENCE:
1. Alam Singh Soil Mechanics in Theory and Practice Asia Publishing House
2. S. K. Gulhati and Manoj Dutta Geotechnical Engineering Tata McGraw-Hill 2005.
3. Purushothama Raj   Geotechnical Engineering Tata McGraw Hill Publishing Co. Ltd. 1995.
4. Punmia B.C. Soil Mechanics and Foundation Engg. Laxmi Publication Pvt. Ltd, New Delhi, 1994.
5. C. Venkatramaiah, Geotechnical Engineering, New Age International Ltd. (Second Edition) 1995.
6. Gopal Ranjan and A.S. RAO;, Basic and Applied Soil Mechanics, New Age International Ltd, 2004.

CEL 312 TRANSPORTATION ENGINEERING   [(3-0-0); Credits: 3]

Course Objectives:
1. Introduce to transportation and traffic engineering.
2. Introduction to transportation planning.
3. Teach geometric design of highways.
4. Teach design of flexible and rigid pavements
5. To teach various laboratory testing for characterization of pavement materials
6. Introduction to bridge engineering

Syllabus:
Introduction: Fundamentals of Transportation System, spatial significance of transportation system, impact an life style, components of the system, Transportation Scenario in India, Five year plans, privatization Efforts, Multilateral funding, Modern Transportation.

Development and Planning: Road transport Characteristics, Classification of roads, development plans, network patterns, data collection and surveys, principles of alignment, evaluation of plan proposals; Traffic Engineering : 3E's of, traffic characteristics, Surveys, Intersection-types, layouts, design principles, Urban traffic, parking, lighting, Accidents, Traffic control Devices-marking, Signs, Signals, Regulations Motor Vehicle Act and Rules

Materials: Sub grade Soil – AASHTO Classification, group Index, Sub grade soil Stabilization. CBR, aggregate Physical and Mechanical properties and tests-Bituminous materials classification sources properties and tests. Cutback and Emulsions, modified Bitumen IRC/IS Standards, Introduction to Geotextiles; Construction and Maintenance: IRC, MOST specifications for quality and quantity of materials, techniques, tools and plant, for the Earthwork, sub base, base and wearing / surfacing course of flexible pavements with gravel, W.B.M., WMM, stabilized Bituminous and concrete as Construction material, Drainage, shoulders, maintenance and repairs

Geometric Design: Road, road user and road vehicle characteristics, Factors affecting design standards. Cross Section elements, stopping and overtaking sight distance overtaking zones. Horizontal alignment-Curves, design of super elevation, widening, 'transition curves, vertical alignments, Design of summit and Valley Curves, I.R.C. standards for Geometric Design, Geometrics of Hill Roads; Pavement Design : Types of pavements and characteristic, Design parameters, Axle and Wheel load, tyre pressure, ESWL for dual Wheels, repetitions, Group Index and CBR method of flexible pavement design. Analysis of load and temperature stresses for rigid pavement, joints.

Bridges: General: Components, classification and identification, Data Collection site selection, Economic Span; Hydrology: Estimation of flood, discharge, water way, scour depth, depth of foundation, Afflux, clearance and free board. Loads, Forces, Stresses: IRC Specification and code of practices, Critical combinations; Sub-Structure: (A)Types of foundations and their choice, estimation of BC of foundation strata, Open, Raft, Pile and well foundation, pneumatic Caissons, cofferdams. (B) Abutment, Piers and Wing wall. Their types, general design principles (empirical), Choice of Super Structure: Culverts, causeways, minor and major bridges, different structural forms and actions. Suitability and choice, precast post tensioned and segmental construction. Launching, operation systems, Bearings, Aesthetics; Rating and Maintenance: Methods and Techniques of rating of existing bridges Inspection, Repairs, maintenance, corrosion-causes and prevention.

Course outcome:
1. Gain a broad understanding of transportation engineering
2. Transportation systems and organizations
3. Driver, vehicle, pedestrian, road and traffic characteristics.
4. Basic understanding of various bridge design parameters
5. Ability to characterize pavement materials
6. Contemporary issues and developments.

REFERRENCE:

1. S.K.Khanna, C.E.G Jesto, Highway Engineering Nemi Chand BrithersRoorkee.
2. DR.K.R.Kadiyali, Traffic Engineering and transportation Planning, Khanna Publisher, Seventh edition.
3. Bindra, Bridge Engg., Dhanpat Rai.
4. Paul H. Wright and Karen Dixon, Highway Engineering, John Willey and Sons.
5. C.S Papacostasand P.D. Prevedouros, Transportation Engineering and Planning (3rd Edition), John Willey and Sons 3rd edition.
6. Garber N.J. and Lester A. Hoel, Traffic and Highway Engineering, West Publishing Co. New York.
7. O' Flaherty and Coleman. A., Transport Planning and Traffic Engineering Edward Arnold U.K.
8. Fred. L. Mannering, Walter P. Kilareski, Principles of Highway Engineering and Traffic Analysis John Willey and Sons.

CEP 312 TRANSPORTATION ENGINEERING   **[(0-0-2); Credits: 1]**

1. Subgrade Soil : AASHTO Classification, group index and rating, CBR test (Vide IS : 2720)

2. Aggregates: Specific Gravity test, Water absorption test, Determination of flakiness and Elongation index, Aggregate Impact Value test, crushing and Abrasion value tests.

3. Petrographic identification (Vide IS : 2386)

4. Bitumen: Penetration, Softening Point, flash point, Ductility, Stripping, Test on modified bitumen, Elastic Recovery.

5. Students should be familiar with relevant BIS, IRC, MOST specifications of various materials for different constructions.

CEL 303-ENVIRONMENTAL ENGINEERING II   **[(3-1-0); Credits: 4]**

Course Objectives:

1. Understand the concept of wastewater, its sources, characteristics, methods of treatment of wastewater and methods of disposal of wastewater.
2. Understand the concept of air pollution and its effects on human, animals, plants and materials.

Syllabus:

General Aspects of Wastewater Engineering; System of collection and conveyance of sewage – separate and combined systems; Patterns of sewage collection systems; Quantity of sewage and storm water;

Sewer: Types, Shapes, Hydraulic Design (Capacity, Size, Grade, etc.); Construction of sewer – Shoring Trenching and Laying to grade. Sewer materials; Sewer Appurtenances – Manhole, Street Inlets, Storm water overflows, Inverted Syphons, Flushing and Ventilation. House plumbing systems – sanitary fitting and appliances, traps, anti-syphonage, inspection chambers and intercepting traps; Sewage pumping – location of pumping station and types of pumps. Sewer testing and maintenance.

Characteristics of wastewater; Sewage treatment flow sheet; Site selection for sewage treatment plant. Preliminary and primary treatment – Screens, Grit chambers, Primary settling tank (including simple design).

Secondary treatment – Principle of Biological Treatment Activated sludge process, trickling filter; Methods of disposal – disposal on land and in water stream, Sewage farming, Self-purification of stream. Sludge digestion, Sludge drying beds. Rural sanitation – Pit privy, aqua privy; Bio-gas recovery; Septic tank including soak pit, (including design problem); Sludge collection and disposal.

Industrial Waste Water Treatment – Significance of Industrial Waste Water Treatment, important physical and chemical parameters, unit operations and treatment processes (flow equalization, neutralization, adsorption, chemical and biological treatment etc.).

Introduction to air pollution; Sources of air pollution and its classification ill – effects of air pollutants on man, animal and materials Meteorological parameters Methods of air pollution control.

Course Outcome:

1. Gain a broad understanding of wastewater engineering
2. Wastewater management systems and design of various treatment units
3. Understand about the disposal of wastewater.
4. Contemporary issues and developments.

REFERENCE:

1. Punmia B.C.; Waste Water Engineering; Laxmi Publication, 2002
2. S.K. Garg; Environmental Engineering; Vol II Standard Publication, 2002
3. Metcalf, Eddy; Wastewater Engineering; McGraw Hill Publication, 2004
4. Macghee M.J.; Water Supply and Sewage; McGraw Hill Publication, 1990
5. Rao M.N.and Rao H.V.N.; Air Pollution; McGraw Hill Publication, 1992
6. Rao C.S.; Environmental Pollution Control Engineering; 1990

CEL 313 CONCRETE ENGINEERING   [(3-0-0); Credits: 3]

Course Objectives:
1. To Emphasis upon importance of concrete as versatile construction material & its suitability & adaptability in concrete construction
2. To study knowledge of Concrete making materials & ingredients &. Various parameters affecting properties of concrete including concrete mix proportioning.
3. To provide need based Knowledge of methods to obtain various types of concretes.
4. Conceptual understanding of Reinforced cement concrete & Properties and design of structural elements like slab, beam column and footings as per Indian standard codes.
5. To study the concept of prestressed concrete its properties & to impart knowledge about its mechanized design & methods in light of modern construction.
6. To analyze & design various prestressed concrete structural elements per Indian standard speciation.

Syllabus:
Portland cement: Types and properties, Tests on Portland cements, Aggregates: classification function, and types. Properties and Tests on aggregates. Water: its quality and recommendations. Production of concrete: mixing, casting, compacting and curing of Concrete, workability concept, tests, workability factors, Admixtures: Purpose, use and Types

Hardened concrete: Tests on concrete, properties and factors affecting properties of concrete,, Non destructive tests on concrete, Concrete mix design and methods of mix design Concepts of durability, Types of concrete

Concepts of Prestressed concrete: Materials, their properties, advantage and disadvantages, methods of prestressing and prestressing systems, Losses in prestress,

Design of R. C.C. and Prestressed Concrete (W.S.M): Reinforced concrete: Design concept, I.S.456-2000 for working stress method, Working stress method: Flexural behaviour of beam under load, Analysis and design of singly reinforced, doubly reinforced rectangular beam sections and "T" and "L" beam sections, Shear and bond stress. Design of simply supported and cantilever beams, Lintels, one-way slab, and cantilever canopy. Design of axially loaded columns and axially loaded isolated footing.
Prestressed concrete: Analysis by Homogeneous beam concept, load-balancing concept, pressure Line. Design of simple rectangular sections like slab and beam.

Course Outcome:
1. Achievement of basic knowledge on Concrete Technology, Concrete production, its type & applications in field of construction.
2. Achievement of Conceptual understanding of what is Engineered concrete?
3. Achievement of Knowledge of pre-stressed concrete ,its requirement in construction , application & design
4. Acquired basic knowledge of design of elementary RCC elements like one way slab, beams, column & footings.

REFERRENCE:
1. Gambhir M.L, Concrete Technology, Tata McGraw Hill, Second, 1995.
2. Shah M.G., Kale.C.M. RCC Theory and Design. Macmillan India Ltd. 1987.
3. N. Krishnaraju; Prestressed Concrete, Tata McGraw Hill, (Third Edition) 198.
4. M.S.Shetty, Concrete Technology, S.Chandand Company New Delhi, 2005.
5. Orchard D.F., Concrete Technology -Vol I., Applied Science Publishers (Fourth Edition) 1979.
6. Neville A.M andJ.J.Brook; Properties of Concrete, Addison Wesley 1999.
7. Lin T.Y,Burns N.H.; Design of prestressed concrete structures. John Wiley and sons. (Third Edition).1982.
8. S. Ramamurtham Reinforced Concrete Design Dhanpat Rai Publications 2009.

CEP 313 CONCRETE ENGINEERING   **[(0-0-2); Credits: 1]**

1. Tests on properties of cement: Standard consistency, Initial and final setting time, Fineness soundness and compressive strength of cement.
2. Tests on aggregates: Sieve analysis, grading, Fineness modulus, Bulk density and specific gravity of coarse and fine aggregate. Deleterious materials, Silt content and Bulking of sand.
3. Measurement of workability of concrete. Slump, compaction factor/ Vee Bee Test
4. Concrete mix design.
5. Casting, curing and testing of concrete for compressive strength.
6. Nondestructive testing of concrete
7. Study experiment on pre-stressed concrete.

Following RCC designs with drawings on A4 size sheet:

1. Design of slab: One way simply supported and cantilever slab
2. Design of beams, Lintels, T and L Beams.
3. Design of. Axially loaded Column with pad/sloped rectangular footing

CEL 305 DESIGN OF RCC STRUCTURES   **[(3-1-0); Credits: 4]**

Course Objectives:
To make Civil Engineering students able to design concrete various RCC members of building using Limit State Design method.

Syllabus:
Limit state Design Concept, Partial safety factors, load factors, stress-strain relationship, stress block parameters, failure criteria, Use of I.S. 456-2000, Limit state of collapse in flexure : Design of one way single span and continuous slabs, canopies and two way slabs with various end conditions using IS code coefficients. Analysis and Design of Singly and Doubly reinforced Beams, "T" and "L" beams.

Moment redistribution analysis and design of fixed beams, propped cantilever, two span symmetric continuous beams. Limit State of collapse in shear, Bond and Torsion, Design for Interaction between Bending moment, Torsional moment and Shear. Limit state of serviceability: Deflection and moment curvature relationship, for beams and one-way slabs.

Limit state of collapse under compression axially loaded short and long column, column with axial load, uniaxial and biaxial moment, Interaction diagram / Charts. Isolated footing for axially loaded columns, Uniaxial bending, combined footing: Rectangular footing, Strap beam, Trapezoidal, raft etc.

Analysis and design of portal frames (single bay single storey) hinged or fixed at base. Design of Cantilever and Counterfort Retaining Walls.

Design of Dog legged and Open Well Staircase. Design of Circular and Rectangular water tank with roof slab / dome resting on ground by approximate method. (Using Working Stress Method).

Course Outcome:
1. To understand conceptually the difference between Working stress method, Ultimate load theory method & Limit state Design method.
2. To design the structural elements like RCC beam, slab, column, and footings by limit state Design method as per I.S.456-2000.
3. To design two way slab & one way continuous slabs
4. To design columns & footings for eccentric loads.
5. To design RCC Retaining walls & design of water tanks.

REFERRENCE:
1. Varghese P.C.; Limit state design of Reinforced Concrete Structures Prentice Hall of India, 1999.
2. Karve S.R. and Shah V.L, Limit State Theory and Design of Reinforced Concrete, Structures Publications, Pune. 2007.
3. S.U.Pillai ,D.Menon: Reinforced Concrete Design, Tata Mcgraw-Hill Publishing Company New Delhi 2003.
4. Ramchandra. Limit state Design Standard Book House 1990. Bureau of Indian Standards, I.S.456-2000: Plain and reinforced concrete, Code of Practice, Bureau of Indian Standards 2000.
5. I.S.3370-1967: Part I, II and Part IV, Code of Practice for Concrete structures for storage of liquids. Bureau of Indian Standards 1967.
6. S.P. (16): Design Aids for Reinforced Concrete. (Interaction Charts Only) Bureau of Indian Standards 1980.

CEL 211 -SURVEYING II   [(3-0-0); Credits: 3]

Course Objectives:
1. To teach about the curve surveying for highways
2. Introduction to Geodetic surveying, Field astronomy, Triangulation, Photographic and hydrographic surveying.
3. To make the students able to do base line measurement and handle Auto Level & Total station in the field for various surveying works.
4. To teach how to compute for geodetic position, how to do triangulation adjustment and apply corrections in geodetic quadrilateral

Syllabus:

Tachometry – Classification, stadia method, Analytic lens, distance and elevation formulae, tangential method, errors.

Curves – Simple, Compound, Reverse, Transition and Vertical Curves : Elements, methods, setting out curves.

Geodetic Surveying – Geodetic Surveying: Classification of triangulation survey, intervisibility of stations field work, reduction to centre, base line measurement corrections.

Triangulation adjustment and Aerial Surveying – Definitions, weighted observations, laws of weights, station adjustment Definitions, classification, tilt and height displacements, height from parallax measurements, flight planning, phototheodolite and stereoscope.

Astronomical Survey and Hydrographic Survey – Astronomical terms Elements of spherical trignomentry, Napier's rule, celestial sphere. Shore Line and River Survey, Soundings, equipments, methods.

Underground Surveying and Global Position System (GPS) – Corelation of underground and surface survey, transferring the levels underground.

Course Outcome:
1. Do curve surveying for highways and railways curves
2. Understand the basics of geodetic surveying, Field astronomy, Triangulation, Photographic and hydrographic surveying.
3. Use Auto level, Total stations and other advanced instruments in surveying
4. Plan and doing surveying in a team for real life works.

REFERRENCE:
1. B. C. Punmia, Surveying II, Standard Book-House, Latest.
2. S. K Duggal, Surveying Volume II, Tata McGraw Hill, Latest.
3. A M Chandra, Higher Surveying, New Age International Publication, Latest.
4. T. P. Kanetkarand S. V. Kulkarni, Surveing and Leveling-Part II, Pune VidhyarthiGrihaPrakashan, Pune Latest.
5. Arthur Bannister, Stanley Raymond, Raymond Baker, Surveying, Person Education.

CEP 211 -SURVEYING II   **[(0-0-2); Credits: 1]**

1. Base Line Measurement.
2. Study and Application of Auto Level
3. Study and Application of Total Station
4. Setting out of simple curves – linear methods
5. Setting out of simple curves – angular method
6. Setting out of transition curve
7. Computation of geodetic position
8. Correction of geodetic quadrilateral
9. Triangulation Adjustments
10. Determination of Azimuth

CEL 307 PROJECT PLANNING AND MANAGEMENT   [(3-1-0); Credits: 4]

Course Objectives:
1. Student shall be able to Plan Bar Chart, material requirement schedule, Manpower schedule, Machinery Schedule.
2. Student shall be able to plan Quality and Safety Checklist for the Construction Site
3. Student shall be able to outline the Construction Labour law for their project site.
4. Student shall be able to check suitable type of machinery for their project site.
5. Students shall be able to estimate rate analysis of Excavation by excavator, Concreting by Batching plant Concrete.

Syllabus

Introduction: Significance of Construction Management, Objectives, Functions, Resources, and Stages in construction, construction team, Organization Structure,

Project planning: Work Break down structure, Bar charts, Detailed Bar chart for a Construction Project, CPM and PERT analysis, Line of balance method. Resources levelling.

Construction Quality: Quality Control, Quality Assurance, Quality Plan, Deming Cycles, Juran and Philip Crosby Principles on Quality, Quality Inspection.

Construction safety: Importance of safety, safety measures, accident cost and its prevention, Safety measures in Excavation, Drilling Blasting, Hot Bituminous work, scaffolding, ladder, formwork

Construction Labour: Payment of wages Act, Workmen's Compensation Act, Minimum Wages Act.

Materials management: Functions and objective, Inventory control, EOQ, ABC analysis

Equipment Management: Classification, selection, Equipment of major projects: Excavating Machines (Shovels, draglines, Bulldozer, Scrapper), Drilling and blasting, Transporting and Handling equipment Cranes, Hoists, Conveyor belts, Dumpers, Cableways. Concrete equipments: Mixers, vibrators, batch mixing plants, Calculation of Unit rate for Excavating Equipment and Concreting Equipment.

Course Outcome:

1. Planning of various construction projects such as Building, Roads, etc.
2. Manpower requirement planning during project
3. Equipment planning
4. Material planning
5. Quality and Safety measures at Site

REFERRENCE:
1. Kumar Neeraj Jha, Construction Project Management, Pearson Publication.
2. Project Management Body of Knowledge, 5th Edition, PMI Global Standard
3. Harvey Maylor, Project Management, 3rd Edition, Pearson
4. K.K. Chitkara, Construction Project Management, 2nd Edition, McGraw Hill Publication
5. P G. Gahoitand B.M. Dhis, Construction Management New age international (p) Ltd.
6. Srinath L, CPM and PERT, East-West Press Pvt. Ltd New Delhi.
7. Frank Harris and Ronald McCaffer, Modern Construction Management, Blackwell Science. 4th Edition.
8. N.D. Vora, Quantitative Techniques in Management, Tata McGraw Hill, New Delhi, 3rd Edition.
9. Daniel Halpin, Construction Management, 3rd Edition, John Wiley and Sons, Inc.

CEL 315 FLUID MECHANICS   **[(3-0-0); Credits: 3]**

Course Objectives:
1. Analyze relative equilibrium of fluids
2. Teach Hydro-kinematics
3. Introduce Boundary Layer Theory
4. Analyze flow through pipes, turbines and pumps
5. Teach Drag and Lift forces

Syllabus:
Relative equilibrium of fluids, Liquid masses subjected to uniform horizontal and vertical acceleration, Acceleration of fluid mass along a slope, Free and forced vortex, Velocity potential function and stream function, flownet, circulation, Kinetic energy correction factor, Momentum correction factor,

Pipe flow, branching, power transmission, syphon, Viscous flow, laminar incompressible flow in a circular pipe, Hydraulically smooth and rough pipes, Moody's diagram, two dimensional laminar flow between parallel plates

Boundary Layer Theory, Displacement thickness, Momentum thickness, Laminar boundary layer

Forces on immersed bodies, Drag and Lift, Magnus effect

Hydraulic turbines and their performance, centrifugal and reciprocating pumps, working principles, specific speed, characteristic curves, Air vessels.

REFERRENCE:
1. Garde R.J. and Mirajgaokar A.G.; Engineering Fluid Mechanics Scitech Publication 2003.
2. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publication, 1996.
3. Streeter V.L. and Wyle E.B.; Fluid Mechanics; International Students Edition, 1986.
4. Modi S.M. and Seth S.M.; Hydraulics and Fluid Mechanics including Hydraulic Machines; PHI learning Pvt.Ltd.2015
5. Som S.K., Gautam Biswas and Suman Chakraborty; Introduction to Fluid Mechanics and Fluid Machines, Mc Graw Hill Education, 2011.

CEP 315 FLUID MECHANICS   [(0-0-2); Credits: 1]

1. Free and forced voetex
2. Laminar flow
3. Model studies for turbines, pumps, losses in pipes
4. Assignments

CEL 311PAVEMENT DESIGN [(3-0-0); Credits: 3]

Course Objectives:
1. Introduction to basic principles pavement design as per IRC.
2. Mechanical properties of pavement material like bitumen and cement.
3. Introduce rigid pavement design and its advantages over flexible pavement.
4. Pavement maintenance

General: Structural action of flexible and rigid pavements. Characteristics of highway and airfield pavements.

Design Parameters: Standard Axle load and wheel assemblies for road vehicles under carriage system for aircraft, Tyre and contact pressure, contact area imprints, Computations of ESWL for flexible and rigid pavements. Load repetitions and distributions of traffic for highway and airfield pavement, airport traffic areas. Material Characteristics: AASHTO subgrade soil classification. Group index, CBR, North Dakota cone bearing value, plate load test for "K", Marshal's method of Bituminous mix design. Modulus of rupture and elasticity, poison's ratio & coefficient of thermal expansion of concrete. Layer equivalency concepts.

Analysis of Flexible and Rigid Pavements: Stress, Strain deformation analysis for single, two three and multi layered flexible pavement systems. Stress and deflections for rigid pavements due to load and temperature, influence Charts, ultimate load analysis, joints in C.C. pavements.

Highway Pavement Design:
    a) Flexible: North Dakota cone, Group index, CBR, IRC-37, Brumister, Triaxial (Kansas), AASHTO method of design.
    b) RIGID IRC-58, P.C.A., AASHO method of design, Design of joints and reinforcement.
Airfield Pavement Design:
    a) Flexible: U.S. Corps of Engineering, CBR, FAA, Mcload (Canadian)
    b) Rigid: PCA, FAA & LCN, ultimate load Analysis yield lines patterns, methods.

Pavement Testing and Evaluation: Trial & Inspection Pits, Field Density, CBR, plate load Test, condition surveys and surface evaluation for unevenness, rut depth, profilometers, Bump integrators, Benkelman Beam Deflection Study. Straightening of Pavement: Design of flexible, composite and rigid overlays for flexible and rigid pavements, Repairs, Maintenance and rehabilitation of pavements. Specifications and Cost Estimates: Review of IRC/MORTH/ICAO/NAAI specification and standards for highway and airfield construction. Cost evaluation and comparative study. Pavement Management Systems, case studies of Highway and Airfield pavement projects.

Course Outcome:
1. Gain broad understanding of mechanical properties of pavement material like bitumen and cement and various methods of pavement design being practiced in India
2. Design a pavement using relevant IS/IRC codes.
3. Carry out bitumen mix design

REFERENCE:
1. Yoder & Witzace, Principles of Pavement Design ; Prentice Hall, 2000
2. Yang N.C., Design of Functional Pavement ; McGraw Hill, 1990
3. Sharma S.C.,Highway Engg. ; Dhanpat Rai, 2000
4. Goyal & Praveen Kr., Airport Planning &Design ;Galgotia Publication, 2002
5. Croney & Croney ; Design and Performance of Road Pavements; McGraw Hill, 2002

CEL 368 ADVANCED HYDRAULICS   **[(3-1-0); Credits: 4]**

Course Objectives:
1. To understand various water surface profiles.
2. To study free surface flow measurements on field.
3. To know the physical modeling laws.

Syllabus:
Channel Hydraulics : Section factor and conveyance, Composite sections, Hydraulic depth and hydraulic slope, Equivalent roughness for channel surfaces, Compound channels, Computation of critical flow, Normal critical slope, Channel transitions, Venturi-flume, Parshall- flume, Theory of gradually varied flow, Analysis of surface profiles of gradually varied flow, Flow profiles for combination of reaches, Hydraulic exponents, Computation of gradually varied flow, Direct integration methods, Step methods, Graphical method, Numerical methods, Specific force diagram, Location of hydraulic jump, Application of hydraulic jump in design of hydraulic jump type stilling basin with horizontal apron, Types of hydraulic jump, Measurement of river discharge, Simple segment method, Simpson's rule, Weddle's rule, Moore's method

Cavitation, Laboratory study, Effects and prevention of cavitation, Cavitation parameter, Aeration of rectangular weir, Submerged sharp crested weirs

Physical modeling : Dimensional homogeneity, Methods of dimensional analysis, Rayleigh's method, Buckingham's method, Model analysis and its advantages, Similitude, Dimensionless numbers, Reynolds number, Froude's number, Mach number, Weber number, Scale ratios, Ship resistance model, Models of pumps and turbines, Distorted models, Various modes of distortion, Scale effects of model testing, River models, Limitations of hydraulic similitude

Course Outcome:

1. Estimate equivalent roughness for compound channels
2. Analyze and compute the Gradually Varied Flow (GVF) profiles
3. Locate the hydraulic jump in prismatic channels

REFERRENCE:
1. Ranga Raju, Flow through Open Channels, Tata McGraw Hill Publication 2004.
2. VenTe. Chow, Open Channel Hydraulics, Tata McGraw Hill Publication (International Students Edition) 2003.
3. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publication, 1996

CEL 401 IRRIGATION ENGINEERING [(3-1-0); Credits: 4]

Course Objectives:
1. To get a feel of problems involved with Irrigation Engineering, socio Economic
2. Study various types & requirements of irrigation, soil moisture relationship Crop patterns.
3. Design & construction of various types of dams.
4. Water conveyance systems – canals & allied structures.

Syllabus:
General: Necessity and importance, scope and development of Irrigation in India, Classification of Irrigation, Comparative study of different irrigation systems

Quality of irrigation water, salt constituents and their effects, Soil moisture – Consumptive use, water requirements of crops Duty-Delta-Base period-Factors affecting duty – Duty for principal types of crops grown in India, reclamation of saline soil.

Reservoir Planning and Management: Investigation- Selection of site – Detail surveys to be conducted and data collection– Determination of field and storage capacity – Determination of L.S.L. and F.R.L. of reservoir sedimentation B-C ratio

Dams: Different types and their suitability – Factors governing the selection of type of dam for project.

Gravity Dam: Forces acting on a gravity dam (including seismic load) – Stability requirement, Design and Construction aspects.

Earthen Dams: Types of Earthen Dams – Factors and general Principles to be considered in the design. Failures of Earthen Dams – Seepage and drainage arrangement

Weirs: Different types of weirs – Spillways – General principles of design – types, spillway gates –energy dissipation downstream of spillway.

Different types of diversion weirs – Component parts of diversion headworks. Causes of failures of diversion, weirs – Weirs on permeable foundation with design principles. Blighs Creep theory, Khosla's Theory, River Training, Guide banks, Groynes and spurs

Irrigation Canals: Types – Design Principles of channels – water losses, sediments and their effects upon stream regime. Reservoir silting silt supporting theory, design of channel in alluvial soils based on silt theories – silt exclusion – silt control. Lining of canals, Design's of lined canals, Water Logging and its Prevention, Drainage of land, methods. Types, description of Canal Structures

Cross Drainage Works: Types and general principles.

Course outcome:
1. Relate with socio economic aspects of agriculture.
2. Understand & assess requirements of irrigation.
3. Have insight of planning & design of storage irrigation systems- Dams.
4. Plan & design irrigation water conveyance systems

REFERRENCE:
1. Garg Santosh Kumar, Irrigation Engineering Khanna Publishers, New Delhi 2002.
2. Aasawa G L Irrigation Engineering Wiley Eastern Ltd. 1996.
3. Creager, Justin, Hinds; Engineering for Dams; 1995.
4. Design of Small Dams U. S. B. R. Publication 1960.

CEL 314 ESTIMATING AND COSTING [(3-0-0); Credits: 3]

Course Objectives:
To estimate the cost of a building from given set of drawings and detailed specifications.

Syllabus:

Estimate and Estimating: Purposes of Estimating, Types of Estimates, Methods of Building Estimates, Units of Measurement of Various Items. Methods of Detailed Estimates, Detailed Estimation of civil Engineering Works: Building (Load Bearing and RCC Framed Structures), Culverts, Hydraulic Structures and Water Supply and Sanitary Works and Road Works.

Specifications: Definition, Objectives, Use, Types, Classification, Design of Specifications, Principles of Specification Writing, Sources of Information and Typical Specifications.

Contracts: Definition, Essential Requirements, Trade usages, Forms of contract, Termination of Contracts, Labour Contract Negotiated Contracts, Schedule of Prices Contracts, Package Deal Contracts, Demolition Contracts, Responsibilities of the Engineer, Contractor and Owner, Earnest Money and Security Deposits, Mobilization Fund, Tender, Opening of Tenders, Scrutiny of Tenders, Acceptance of Tender, Revocation of Tender, Tender form, Unbalance Tender, Liquidated Damages, Advertisement, contract Documents, Qualification of Contractors, Direct and Indirect Costs, Basic price Contracts. Conditions of Contract: Definition, Object, Importance, Peculiarities, General Provisions, Typical Clauses of the Conditions of Contract, Conditions of Contract in Outlines.

Rate Analysis: Purposes of Rate Analysis, Factors affecting, importance, Schedule of Rates, Task works per Day, Rate analysis of typical Items.

Valuation: Purposes, Cost, Price and Value, Forms of Value, Classification of Property, Freehold and Leasehold Properties, Sinking Fund, Amortization, Depreciation and Obsolescence, Outgoings, Gross Income and Net Income, Capitalized value, Deferred Land Value, Year's Purchase, Rate of Interest, Mortgage, Legal Mortgage, Accommodation Land and Accommodation Works, Annuity, Land Valuation, Methods of Land Valuation, Rent fixation.

P.W.D. Accounts and Procedure for Works: Organization of Engineering Department, Works, Classification of Works, Methods of Carrying out Works, Measurement Book, Stores, Stock, Issue Rates, Tools and Plants, Mode of Payment, Public Works Account, Power of Sanction, Duties of Overseers Travelling Allowances.

Course Outcome:
1. Estimate the cost of any building.
2. Design technical specifications for any project.
3. Invite tenders and arrange contracts on behalf of Govt.
4. Carry out rate analysis of various items in construction.
5. Fix the value of built-up properties and land, fixation of rent for a property.

REFERRENCE:
1. Rangawala S.C., Estimating, Costing and Contracts, Chortor Publications, 2004.
2. Dutta B.N. Estimating and Costing in Civil Engineering, UBS Publication, 2004.
3. M.Charborty, Estimating and Costing, Authors Publication Kolkatta 1998.

CEP 314 ESTIMATING AND COSTING [(0-0-2); Credits: 1]

1. A Complete set of Contract document (Including specifications along with a building estimate)
2. Detailed Estimate of the Following (Any Two): RCC Framed Structure, Hydraulic Structure, Steel Structure, Culvert, and Road Work.
3. Rate Analysis of 10 Major Terms of Building.
4. Earth Work of Road for minimum 1 Km Length.
5. Practical examination shall consist of viva voce based on the syllabus and a sessional work.

CEL 404 RAILWAY AIRPORTS, PORTS AND HARBOR ENGINEERING   [(3-0-0); Credits 3]

Course Objectives:
1. Introduction to basic design of railway, airport and ports.
2. Geometric design of railway tracks.
3. Planning of an airport design of airstrip and facilities at airport.
4. Planning of ports and harbors.

Syllabus:

Railway Transportation and its development: Long term operative plans for Indian Railways. Classification of Railway lines and their track standards, Railway terminology, Railway Administration and Management. Traction and tractive Resistance, Hauling capacity and tractive effort of locomotives, different Types of Tractions.

Permanent Way: Alignment Surveys, Requirement, gauges, track section, Coning of wheels, Stresses in railway track, high speed track. Rail types and functions, selection of rails, Test on rails wear and defects, corrugations and creep of rails. Rail joints short and long welded panels. Sleepers – functions, types, merits and demerits, sleeper density. Ballast cushion, Ballast section Rail fixtures and fasteners. Geometric design of railway track, Gauge, Gradient, speed, super elevation, cant deficiency, Negative super elevation, curves, length of transition curves, grade compensations.

Points and crossings: Left and right hand turnout, design calculation for turnout and Crossover, railway track Junctions.

Stations and Yards: Types, functions facilities and equipment.

Railway signaling and Interlocking: Objects and principles of signaling classification and types of signals, control and movement of trains, track circuiting. Necessity of interlocking, methods and mechanical devices. Railway track construction, Inspection and modern, techniques of maintenance. RDSO standards. Modern Technology related to track and traction, Rolling Stock, Signaling and Controlling.

Development of Air Transportation in India: Comparison with other transportation modes. Aircraft components and characteristics, Airport site election. Modern aircraft's. Airport obstructions: Zoning Laws, Imaginary surfaces, Approach and Turning zone, clear zone, vert. Clearance for Highway and Railway.

Runway and taxiway design: Windrose, cross wind component, Runway Orientation and configuration. Basic runway length and corrections, runway geometric design standards. Taxiway Layout and geometric design standards. Exit Taxiways. Airport layout Airport classification: Terminal Area, Aircraft parking and parking system. Unit terminal concept, Gates space standards, Aprons, Hangers, International Airports layouts, phase development Helipads, and Heliports. Visual Aids: Airport marking and Lighting for runway, Taxiway and other areas.

Air traffic control: Need, Network, control aids, Instrumental landing systems, Advances in Air-traffic control.

Docks and Harbor: Importance, Sea and tides, tidal theories, tide table, wind waves and Cyclones, harbour layout, break waters, jetties and moorings.

Course Outcome:
1. Knowledge of basic design of railway, airport and ports.
2. Knowledge of geometric design of railway tracks.
3. Knowledge of planning, designing of airstrip and facilities at airport.
4. Knowledge of ports and harbor planning.

REFERRENCE:
1. Saxena; Railway Engineering.
2. Richard de NeufvilleandAmedeoOdoni, Airport System Planning, Design and Management, McGraw Hill Book Company.
3. Oza H.P., Oza G.H. Dock and harbour Engineering, Charotar.
4. William W. Hay, Railroad Engineering, 2nd Edition, John Willey and Sons.
5. Srivastav R., Docks harbour and tunnels engineering, Charoter.
6. Goyal and Praveen Kumar, Airport Planning and Design, Galgotia Publication.

CEL 409-QUALITY AND SAFETY IN CONSTRUCTION   **[(3-0-0); Credits 3]**

Course Objectives:
1. To introduce the students about quality and safety related challenges in construction industry
2. To make students aware about the globally recognized guidelines/theories for quality and safety in construction
3. To make students self efficient to audit quality and safety related challenges in construction

Syllabus:
Total quality management concepts; ISO9000; QA/QC systems and organizations, Quality Audits; Problem solving techniques; Statistical Quality Control; Quality Function Deployment; Material Quality Assurance; Specifications and Tolerances.

Safety issues; Injury accidents and their causes; Safety program components; Role of workers, Supervisors, Managers and Owners; Safety Procedures for various construction operations; Safety audits; Safety laws.

Safety Organization and Management: Safety policies, safety organization, safety committees, safety representatives, outside agencies – Govt. intervention, international agreements.

Course Outcome:
1. Gain a broad understanding of quality and safety in construction
2. An ability to function on multidisciplinary teams
3. Contemporary issues and development
4. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

REFERRENCE:
1. Levitt, R.E. and Samelson, N.M., Construction Safety Management, Mc. Graw Hill Book Company, Inc., N.Y. 1991.
2. Juran Frank, J.M. and Gryna, F.M., Quality Planning and Analysis Tata McGraw Hill 1982.
3. Raymond Elliot Levitt and Nancy Morse Samelson Construction Safety Management Amazon Second edition.
4. Grant E.L. and Leavensworth Satistical quality Control McGraw Hill 1984.
5. Hutchins G, ISO 9000, Visa Books, New Delhi, 1993.
6. Ron Baden Hellard, Total Quality in Construction Projects, Thomas Telford, London.

CEL 413-PRE-STRESSED CONCRETE STRUCTURE   **[(3-1-0); Credits: 4]**

Course Objectives:
1. To bring the civil engineers to such a level so as to as enable them to take the appropriate decision in respect of choice of Prestressed section over R.C.C.
2. To make the learners to be aware of such a highly mechanized technology in civil engineering construction.
3. To imbibe the culture of entrepreneurship in precast prestressed industry in mass housing .railway sleepers, electric transmission poles etc.
4. To understand the basic design considerations in prestressed concrete structures in relation to its applications.
5. To employ & develop new techniques in rehabilitation of distressed structures like buildings, Bridges & infrastructures.

Syllabus:
Design of high strength concrete mixes. Loss of prestress in single span and continuous beams. Use of IS 1343-1980, Analysis Limit State Design of beams for Tension Type II and III problems, Cracking moment, untensioned reinforcement, Partial prestressing, Stress Corrosion.

Transfer of prestress by bond, Transverse tensile stresses, End zone reinforcement. Behaviour of Bonded and unbounded prestress concrete beams.

Deflection of Prestressed concrete members, short and long term, control of deflections. Crack width considerations. Flexural strength of prestressed concrete sections: Types of flexural failures, Limit state concept.

Shear resistance of prestressed concrete members: Principal stresses and ultimate shear Resistance, Design of shear reinforcement, prestressed concrete, members in Torsion, Design of reinforcement in torsion shear and bending.

Stress distribution in end block, Analysis and Anchorage Zone reinforcement. Composite Construction of prestressed precast and cast in situ concrete. Statically Indeterminate structures: Continuous beams, primary and secondary moments, Continuity, concordant cable profile, Analysis and Design of continuous beams.

Prestressed concrete pipes and poles. Design of prestressed concrete tanks. Prestressing of dams and bridges: Method of construction. Stage prestressing, Dynamic and Fatigue behaviour of prestressed concrete.

Course Outcome:
1. Achievement of adequate knowledge in prestressed concrete structures ready for its dissemination & application.
2. Achievement of adequate knowledge in industrial requirements of prestressed concrete.
3. Emergency preparedness in case repairs & rehabilitation of structures in case of disasters like earthquake, fatigue & dynamic loadings etc.
4. Updating of knowledge in design & research.

REFERRENCE:
1. Nigel R Hewon Prestressed Concrete Bridge, Design and construction Thomas Telford London 2003.
2. Plan Cast Precast and Prestressed concrete (A Design Guide) Devid A. Sheppard and William R. Phillps Mcgraw Hill Publication Co. 1989.
3. N. Krishnaraju Prestressed Concrete Tata McGraw Hill (Third Edition) 1981.
4. Lin T.Y,Burns N.H. Design of Prestressed Concrete Structures. John Wiley and sons (Third Edition).1982.

CEL 414 WATER DISTRIBUTION SYSTEMS   [(3-1-0); Credits: 4]

Course Objectives:
1. Introduction to Water Distribution Networks
2. Methods for Analysis
3. Types of Analysis
4. Methods for Designs

Syllabus:

General Hydraulic Principles, Head loss formulae- Darcy-Weisbach formula, Hazen – Williams formula, Modified Hazen-Williams formula, Series and Parallel connection of Pipes, Equivalent Pipes, Analysis of branched Water Distribution Networks.

Formulation of Equations for looped Water Distribution Networks, Analysis of flow in looped networks using Hardy Cross, Newton-Raphson and Linear Theory method, Introduction of Gradient method and other methods of analysis.

Reservoirs, Pumps and Valves (check valve, flow control valve and pressure reduces valve) in Water distribution systems. Flow dependent analysis of multi-reservoir systems, Introduction to head-dependent analysis.

Node flow analysis of water distribution networks: Node head–flow relationships, Direct and Indirect methods, Application of NFA technique to serial networks.

Optimal and Economical diameter of pumping main, Design of pumping main considering diameter as continuous as well as discrete variable. Water hammer consideration.

Design of water distribution networks using Critical Path Method, Formulation of optimization model, Application of Cost-head loss ratio method and Linear Programming Technique to optimal design of branched networks.

Determining number of branching configuration for a looped network, Use of path concept and minimum spanning tree concept, Application of critical path method for design of looped networks. Introduction to methods for Looped WDNs.

Course Outcome:
1. Types of problems in water distribution systems
2. Methods for analysis of existing network
3. Various types of analysis of the networks
4. Analysis of networks with controlling elements
5. Design of new networks and strengthening of existing system

REFERRENCE:
1. Bhave , P.R. and Gupta R., Analysis of water distribution Networks, Nawas Publishing Co, New Delhi.
2. Bhave P.R., Optimal Design of Water Distribution Networks Nawas Publishing Co, New Delhi.
3. Jeppson R.W., Analysis of flow in pipe networks, Ann Arbon Science AunArbox Michigan USA.
4. Walksi T-M, Analysis of water distribution System Van NostandReinheld G, New York USA, 1984.
5. CPHEEO, Mannual on Water Supply and Treatment, Ministry of Urban Development G01.

CEL 415 ADVANCED STRUCTURAL DESIGN   **[(3-1-0); Credits 4]**

Course Objective
1. To understand the Philosophy of Design of RCC & Steel Structural Elementswith advanced concept.
2. To acquire the skill & knowledge about design of special & typical structures in steel & concrete.
3. To design simple structural forms in roof structures in RCC & steel.
4. To study the Concept of design with respect to plastic Design of steel structural elements.
5. To study the basics of Optimum & minimum weight design of structural elements.

Syllabus:

RCC Structures: Design for Structural reliability and study of structural safety. Design of typical staircases, Design of flat slabs. Analysis and Design of Building frames Yield line theory for slabs. Design of precast building elements, Design of Plain concrete walls and simple shear wall. Design of piers and abutments, Design of cylindrical and doubly curved shell by approximate method.

Steel Structures: Design of Steel tanks and chimney and bunkers. Plastic analysis and design for steel structures, plastic hinge concepts collapse load calculations. Design for upper bound and lower bound solutions and mechanisms. Design of single span and continuous beams, columns, Gable and Portal frames. Design of light gauge steel sections and members, minimum weight design

Course Outcome:
1. To understand the Philosophy of Design of RCC & Steel Structural Elementswith advanced concept.
2. To acquire the skill & knowledge about design of special & typical structures in steel & concrete.
3. To design simple structural forms in roof structures in RCC & steel.
4. To study the Concept of design with respect to plastic Design of steel structural elements.
5. To study the basics of Optimum & minimum weight design of structural elements.

REFERENCE:
1. Varghese P.C.; Advanced Reinforced Concrete Design, Prentice Hall of India.2001
2. Borg ,Gennaro ; Structural Analysis , Affiliated East-West press ltd. VamNostrand company Design
3. Pillai ,S.U.,D. Menon Reinforced Design by, T M H Publication,(Second Edition)2003
4. Dr. Ramchanra; Design of steel structures- Vol. II ,(Fourth Edition),Standard publishing house1984
5. Duggal S.K.; Design of steel structures, Tata McGraw Hill 1993.
6. Dayaratnam P.; Design of reinforced Concrete Structures.(Fourth Edition)Oxfordand IBH.1984
7. Baker A.L.L.; Steel skeleton E.L. B.S. London 1954
8. Neal B.G.; The Plastic Methods of Structural Analysis Chapman and Hall 1953
9. Ranganathan R.; Reliability Analysis andDesign of Structures. Tata McGrawHill1990
10. Arya A.S.,J.L.Ajamani;Design of Steel Structures,Nemchandand Bros.1989

CEL 435 REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

[(3-1-0); Credits: 4]

Course Objectives:
1. Understanding the Geoinformatics approach
2. Teach fundamental principles involved in RS and GIS
3. Understand the Fundamentals of Remote sensing Products
4. Know the Indian Remote Sensing Program
5. Role of Remote Sensing for various surveys and information extraction
6. Know about different software available in RS and GIS
7. Learn fundamental procedures in RS and GIS
8. Teach data integration and defining problems in digital format

Syllabus:

Definition & Scope of Remote Sensing: Electromagnetic energy & spectrum, Atmospheric windows. Remote Sensing Systems, Sensors & Scanners, Resolution of sensors, Multispectral, thermal & Radar data. Radiometers, spectral Signatures.

Elements of Remote Sensing Systems: Terrestrial, airborne &spaceborne platforms, sunsynchronous & Geostationary satellites. Various earth resources satellites, Indian Remote sensing Programs. Remote Sensing Data products & their types: Analogue & Digital data Formats, errors. Interpretation Techniques: Elements & Methods of interpretation, Relief displacement and vertical exaggeration, Photogrammetric determination of elevation from Remote Sensing Data.

Digital Image Processing: Image rectification & restoration, image enhancements, image classification; supervised & unsupervised, accuracy assessments.

Geographical Information Systems: Raster & Vector Data, Components of GIS, concepts & basic characteristics of Vectorization, topology generation, attribute data attachment, editing and analysis. Buffer, Overlay and Interpolation techniques. Managing networks in GIS. Global Positioning Systems: Types and method.

Applications: Integrated approach of RS & GIS application; Geotechnical investigations (soil studies, dam site studies), water resources management, environmental studies (EIA and Land Use Land cover studies), transportation planning, Urban Planning, E-Governance.

Practicals:
1. RS Data formats & their study; analogue & digital data products
2. Image registration
3. Digital enhancement
4. Image classification
5. GIS : Vector data generation, Data attachments and analysis
6. Data analysis in GIS
7. Case studies: Water resources, environmental applications, geotechnical investigations

Course Outcome:
1. Understand the remote sensing process
2. Understand digital data in different and their formats
3. Know about National and International RS Programs
4. Know about various satellites and images
5. Know about changing field practices in Survey
6. Know how to generate different types of digital data
7. Know about Application areas

REFERRENCE:

1. M. AnjiReddy BS Publications Remote Sensing and Geographical Informatiotn Systems Third Edition.
2. C.P LO Albert KW Yeung, Concepts and techniqes of Geographic Infromation Systems Pritince Hall of India 2002.
3. John R Jensen Remote Sensing of the Environment ..an Earth Resource Perspective Pearson Education 2006.
4. Geographic Informaiton System and Enviornment Modeling Keith C. Clerk, Bradely O Parks, Michel P Crane Pritince Hall of India 2002.
5. Bhatta Remote Sensing and GIS Oxford University press First Edition.

CEL 417 DISASTER MANAGEMENT   **[(3-0-0); Credits: 3]**

Course Objectives:
1. To introduce the students about the challenges/phases in disaster management.
2. To make students aware about technologies, which can be implemented for solving the problem of disaster management.
3. To make students self-efficient to solve the challenges with the aid of technological aids.

Syllabus:

Introduction to Disasters- Overview, Classifications, causes, loss of resources

Disaster Risk Management- Objectives, Processes, Events, analysis, base-line data, forecasting and warning.

Emergency operation centre and IT aids- physical environment, IT Aids, Applications.

Techno-legal and Techno-financial aspects- regulatory mechanism for compliance, administrative structure for legal framework, additional cost on infrastructure, building by-laws.

Public-private agency co-ordination- federal, state and local disaster response organization and network, citizen and community role in disaster response and recovery.

Case studies: Natural and man-made disasters, preparedness and planning.

Course Outcome:
1. Gain a broad understanding of disaster management.
2. Broaden the education necessary to understand the impact of disaster in a global, economic, environmental, and societal context
3. Contemporary issues and development
4. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

REFERRENCE:
1. D B N Murthy Disaster Management: Text and Case Studies, Deep and Deep Pvt. Ltd.
2. S L Goel, Encyclopedia of Disaster Management, Deep and Deep Pvt. Ltd.
3. G K Ghosh, Disaster Management, A P H Publishing Corporation.
4. Satish Modh, Citizen's Guide to Disaster Management Macmilan.

CEL 419 RIVER ENGINEERING   **[(3-0-0); Credits: 3]**

Course Objectives:
1. Introduce to the application part of open channel flow.
2. Making students understand the importance of nature and the complications involved in natural processes.
3. To expose students to complex scenarios and explain hen the importance of various equations and the concepts in handling the situations.
4. To make students understand the correlation between complex natural events and the difficulties in addressing them from engineering view point.

Syllabus:

Origin and properties of sediments: Nature of sediment problems, origin and formation of sediments, properties of sediments, incipient motion of sediment particles, tractive force approach, cohesive materials .

Regimes of flow: Description of regimes of flow, ripple, dune, antidune, prediction of regimes of flow. Resistance to flow and velocity distribution in alluvial streams, velocity distribution in turbulent flow over rough boundaries, resistance and velocity distribution in alluvial streams.

Bed load transport and saltation: Bed load equations, bed load equations based upon dimensional considerations and semi-theoretical equations, general comments on bed load equations, saltation.

Suspended load transport: Mechanism of suspension, equation of diffusion, sediment distribution equation, relations for suspended load, wash load, transport of suspended sediment.

Total load transport: sediment samplers design of canals carrying sediment laiden water. Types of sediment samplers. Design of channels carrying sediment laiden water. Sediment transport through pipes

Course Outcome:
1. Understand the relation between formulations and occurrences in nature.
2. Application of equations of Hydraulic Engineering in the understanding river systems.
3. Will develop analytical skills in handling variety of data.
4. State of art research and their applications.

REFERRENCE:
1. Garde R J and Ranga Raju K G, Mechanics of Sediment Transportation and Alluvial Stream Problems Wiley Eastern Ltd., 1985.
2. Yang C.T., Sediment Transport- Theory and Practice The McGraw Hill Companies Inc. 1996.
3. Chang H.H., Fluvial Processes in River Engineering John Wiley 1988.
4. Simons D.B. and Senturk F., Sediment Transport Technology, Water Resources Publications, Fort Collins, Colorado 1977.

CEL 422- HAZARDOUS WASTE MANAGEMENT   **[(3-0-0); Credits 3]**

Course Objectives:
1. To introduce hazardous waste materials.
2. Teach about the generation, classification and categories and sources of hazardous waste.
3. Teach about the methods of treatment and management of hazardous waste.
4. Various rules about the management and handling of hazardous waste.

Syllabus:
Generation, storage, transportation, treatment, disposal, exchanges and minimization, legislative and technical aspects, current management practices; Environmental audits, pollution prevention, facility development and operations, treatment and disposal methods; physical, chemical, thermal, biological processes, land disposal with general applications to the industrial and energy-producing sectors, Site remediation. Special wastes, such as infectious and radioactive waste.

Course Outcome
1. Gain a broad knowledge about the hazardous waste
2. Understand sources and classification of hazardous waste.
3. Waste minimization techniques
4. Management of hazardous wasteVarious rules and regulations for the management and handling of hazardous waste

REFERRENCE:
1. M. D. LaGrega, P.L.Buckingham and J.C.Evans, Hazardous Waste Management, McGraw-Hill, Inc., New York, 1994.
2. W.S.Forester and J.H.Skinner, International Perspective on Hazardous Waste Management, Mudra Offset Printers, Bajaj Nagar Nagpur, 2001.
3. G.W.Dawson and B.W.Mercer, Hazardous Waste Management, Academic Press, Inc., London, England 1987.
4. H.M.Freeman, Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw-Hill, Inc., New York, 1989.
5. E.J.Martin and J.H.Johnson, Jr., Hazardous Waste Management Engineering Van Nostrand Reinhold Co. Inc. New York, 1987.

CEL 425 FINANCIAL AND BUSINESS MANAGEMENT   **[(3-0-0); Credits 3]**

Course Objectives:
To make Civil Engineering students able to prepare business plan by analyzing the economic and market situations.

Syllabus:

Principles of management and Personnel management: Economic environment of business, Introduction to managerial economics, ; Role of a Manager: Tasks and responsibilities of a professional manager, Human Resource development systems Organization structure and design, manpower planning Processes Managerial skills and Management Systems, techniques and processes, SWOT Analysis.

Business Policy and Strategic Management: Assessment of capital requirement and sources of capital planning the establishment and development of business, fixed and current assets, liquid resources, Forecasting of business, cash flow, effect of taxation, Public and private sources of finance, methods of obtaining finance from external sources and internal sources, cost of capital, forms of capital structures.

Value engineering and quality assurance: Marketing planning and organization, marketing research and Marketing strategies, determinants of consumer behavior, Models of consumer behavior, Pricing and promotion strategies. Business forecasting, Modern Control Systems, Total quality Management (TQM), JIT, DSS, ERP, Strategic Management, Technological innovation and creativity.

Financial Management: Meaning and Scope, Economics and Scope, Supply and Demand Mechanism, analysis and forecasting. balance sheet, profit and loss account, fund flow statement; Production and Cost theory, analysis. Pricing; objectives, determinants, absorption, marginal costing. Financial analysis, Decisions. Capital Budgeting, budgetary control, standard costing and variance, investment appraisal.

Construction Finance: Accounting information and application, Financial versus economic evaluation, financial statements and project appraisal. Project yield, taxation and inflation, risk and uncertainty, Turnkey activities; finance and working capital, depreciation and amortization; cost control, performance budgeting, equipment rentals. Bidding and awards, work pricing, cost elements of contracts, letters of credit, financing plans, multiple sources of finance. Qualifying, bidding, bidders, comparing the bids, under-writing. unforeseen revisions, costs and rates escalation, cost progress reporting. Legal aspects.

Course Outcome:
1. Analyse the management system of the organisation
2. Understand the role of manager and skills required
3. Use the swot analysis in decision making
4. Understand the terminology in marketing, HR, finance, Accounting apply knowledge in industry for effective management

REFERENCES:
1. Peterson, H.C., Lewis, W.C. Managerial Economics, Prentice Hall of India Pvt. Ltd., 2001
2. Parkin, M. and Bade R., Modern Macroeconomics 4th Edition, Prentice Hall, 1996
3. Wertherand Davis, Human Resources and Personnel Management, McGraw Hill, 1996
4. Edwards, John et.al., 1983 Manpower planning, John Wiley: New York
5. Anthony, R.N. Govindrajan, V., Irwin, Management control systems, McGraw Hill 10th Edition, 2000
6. Baumel, W.J., A.S. Blinder and W.M. Scarth, Economics: Principles and policy, Academic Press Canada, Tornoto, 1985
7. Anthony and Reece, accounting Principles, AITBS, Sixth Edition,1998
8. Koontz O'Donnel : Essentials of Management; Tata McGraw Hill, 1982
9. Monappa A., Personnel Management, Tata McGraw Hill,

CEL 436-COMPUTER AIDED ANALYSIS AND DESIGN   **[(3-0-0); Credits: 3]**

Course Objectives:
1. To introduce the students about the application tool useful for civil engineering.
2. To make students aware about techniques and programming aids which can be implemented for solving the problem of civil engineering?
3. To make students self efficient to solve the challenges with the aid of technological aids.

Syllabus:
Introduction to CAAD and computer graphics: Overview, programming language, application area, software environment. Data types, graphics devices, representation of images, transformations, computer aided drafting.

Programming language and techniques: Overview, variables and data types, operators, input-output, control structures, functions, arrays, pointers, strings, data-files, trees, and recursion.

Database management system (DMBS): Introduction, Components of DBMS, Data Models, query language, design of database

Knowledge based expert system: Introduction, Artificial intelligence, components of expert system, knowledge representation, inference mechanism, and building expert system.

Simulation: Introduction, Concept of System, models and its purpose, types, approaches.

Analytical Tools: Introduction and application of Finite Element Method, Optimization, Genetic Algorithm, Fuzzy Logic. Application of IT aides for Civil Engineering Applications like Building Technology and Construction Management.

Course Outcome:
1. Knowledge of application tool for civil engineering.
2. Application of techniques and programming aids and implementation in civil engineering problem solving.
3. Students should be able to solve the challenges with the aid of technological aids.

REFERRENCE:
1. Vijay duggal, Caad primer, a general guide to computer aided design and drafting
2. D F Rogers and J A Adams Mathematical Elements of Computer Graphics. Tata McGraw-Hill Publishing Company
3. E V Kameshwar Numerical Techniques in 'C' BPB Publication.

CEP 436-COMPUTER AIDED ANALYSIS AND DESIGN   [(0-0-2); Credits: 1]

10 lab experiments will be conducted based on above topics.

CEL 441 GEOTECHNICAL ASPECTS FOR DESIGN OF MACHINE FOUNDATION

[(3-1-0); Credits 4]

Course Objectives:
1. Introduction to vibration of a system.
2. Concept of different mode of vibration.
3. Physical significance of wave propagation theory.
4. Relevant soil parameters and Instrumentation.

Syllabus

Introduction: Vibration of elementary systems-vibratory motion-single degree freedom system-free and forced vibration with and without damping.

Mode of vibration: Basic theory of vibrations-free and forced vibration of single degree of freedom with and without damping-two degrees of freedom with and without damping-dynamic soil properties-mass spring model and constants- elastic half space approach-determination of dynamic soil constants in laboratory and field based on IS code provisions. Modes of vibration of block foundation – natural frequency of foundation of soil system by Barkan's approach-methods of analysis-Barkan's method. Vertical translations, sliding, rocking, yawing (IS code method).

Concept of waves and wave propagation: Wave propagation in an elastic homogeneous isotropic medium-Raleigh, shear and compression waves in elastic half space.

Dynamic properties of soils: Elastic properties of soils-coefficient of elastic, uniform and non-uniform compression – shear effect of vibration dissipative properties of soils-determination of dynamic properties of soil codal provisions.

Design procedures: Design criteria -dynamic loads - simple design procedures for foundations under reciprocating machines – machines producing impact loads - rotary type machines with Code Provision.

Vibration isolation technique: Vibration isolation technique-mechanical isolation-foundation isolation-isolation by location isolation by barriers- active passive isolation tests.

Tutorial:
1. Determination of degree of freedom for different systems.Single degree freedom system-free and forced vibration with and without damping, determination of natural frequency, damping ratio etc.

2. Determination of natural frequency of foundation- soil system by Barkan's approach and IS code method (IS 2974-PART 1, 2, 3 and 4).
3. Determination of dynamic properties of soil for real sites, numerical.
4. Simple design procedures for foundations under reciprocating machines, using IS Code provisions. A complete design problem will be practiced.

Course Outcome:
1. Gain a broad understanding of Vibration of a system.
2. Get accustoms with mode of vibration and wave propagation concept.
3. Knowledge of different instruments and relevant soil parameters for design of foundation.
4. Contemporary issues and developments.

REFERENCES:
1. Bhatia, K.G. (2008). "Foundations for Industrial Machines—A Handbook for Practising Engineers",D-CAD Publishers, New Delhi.
2. Kameswara Rao, "Dynamics Soil Tests and Applications", Wheeler Publishing, New Delhi
3. Saran Swami, "Soil Dynamics and Machine Foundation", Galgotia Publication.

4. Barkan, D.D. (1962). "Dynamics of Bases and Foundations", McGraw-Hill Book Company, NewYork, U.S.A.

5. Kramar S.L, "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd 54

CEL 442- GEOTECHNICAL INVESTIGATION FOR CONSTRUCTION PROJECTS

[(3-0-0); Credits: 3]

Course Objectives:
1. To make the students capable of solving real problems related to Geotechnical engineering, once he/she join industries as a fresh geotechnical engineer.
2. In this course all the topics will be taught from the application point of view with examples from case histories and a student will get a chance to apply his theoretical knowledge to solve real geotechnical challenges.
3. Introduction with advance methodology, techniques and tools related to geotechnical investigation
4. To discuss ground improvement with various methodologies.

Syllabus:

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical 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. Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Geotechnical specification and proposal and report writing, boring log preparation, Safety measures, Geotechnical risks.

Geotechnical Processes: Field compaction, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control in field.

In-situ 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.

Geotechnical Engineering Case Histories**:** Earthen dam and reservoir, Industrial Structures, Ground Liquefaction, opencast coal mining, landslides, failure of geotechnical structures under critical natural hazards, debris flow, forensic geotechnical investigation.

Course Outcome:
1. Write geotechnical proposal, specification and reports.
2. Bore logging and trial pit logging.
3. Supervise field and lab testings of soil and rocks.
4. Collect and analyze geotechnical data for various construct projects.
5. Analyse and suggest proper ground improvement technique for problematic ground conditions.

REFERENCES:
1. S. K. Saxena, S. A. Gill and R. G. Lukas **,**Subsurface Exploration and Soil Sampling , American Society of Civil Engineers
2. Raj Purushothama, Ground Improvement Techniques , Laxmi Publications

CEL423 INTRODUCTION TO SOIL DYNAMICS [(3-0-0); Credits: 3]

Course Objective:
This course is designed to provide an introduction to dynamics with Soil Dynamics and Geotechnical Earthquake Engineering. The fundamental theoretical and computational aspects of dynamics are developed for important geotechnical problems. The topics include: foundation vibration, dynamic soil structure interaction, construction-induced vibration, seismic ground motion, dynamic response of soil sites, and soil liquefaction.

Syllabus:

Introduction to dynamic loading: Earthquake loading, machine vibrations, blast loading, background and lessons learnt from damages in past earthquakes due to soil and ground failure, effect of soil on seismic response of structures, seismic waves and their characteristics

Dynamic soil properties: Static and dynamic characteristics of soils, stress-strain behaviour of cyclically loaded soils, effect of strain level on the dynamic soil properties, equivalent linear and cyclic nonlinear models, measurement of seismic response of soil at low and high strain, using laboratory tests, cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, plate load test, block vibration test, SASW/MASW tests, cross bore hole

Ground Response Analysis: Introduction to 1, 2 and 3 D ground response analyses, derivation of 1 D ground response analyses, equivalent linear and nonlinear approaches, fundamental period of uniform and layered soil

Soil Amplification: Effects of local soil conditions on ground motion, concept of response spectra, instrumental, experimental and numerical methods to determine soil amplification factors, standard spectral ratio, surface to borehole ratio, H/V ratio for noise and microtremors, Indian response spectra for different soil types IS 1893 Part 1

Soil-Structure Interaction: Introduction to soil-structure interaction, direct and substructure methods of analysis, kinematic interaction, inertial interaction, foundation damping, effect of base slab averaging and embedment, SSI analyses for nonlinear static analyses of structures

Liquefaction: Effects of liquefaction, pore pressure, liquefaction related phenomena – flow liquefaction and cyclic mobility, factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility, evaluation of liquefaction potential, characterization of earthquake loading and liquefaction resistance, cyclic stress ratio, Seed and Idriss method.

Course Outcome:
In this course, the students are expected to learn
1. Basic Theoretical and Computational Dynamics
2. Earthquake and Seismic Hazards
3. Strong Ground Motion Characteristics
4. Design Ground Motion at a Site
5. Dynamic Response Analysis
6. Effect of Local Site Conditions
7. Soil Liquefaction
8. Foundation Vibration Analysis
9. Dynamic Soil Structure Interaction
10. Construction-induced Vibration

REFERENCES:
1. Prakash, S. (1981). Soil dynamics. New York: McGraw-Hill.
2. Kramer, S. L. (1996). Geotechnical earthquake engineering (Vol. 80). Upper Saddle River, NJ: Prentice Hall.
3. Ranjan, G., and Rao, A. S. R. (2007). Basic and applied soil mechanics. New Age International.
4. Kameswara Rao, N. S. V. (2000). Dynamics soil tests and applications.Wheeler Publishing Co. Ltd., New Delhi, India.
5. Robert, W. D. (2002). Geotechnical Earthquake Engineering Handbook. NY: McGraw-Hill.

6. Saran, S. (2006). Soil dynamics and machine foundations. Galgotia Publications.
7. Wood, D. M. (1990). Soil behaviour and critical state soil mechanics. Cambridge university press.
8. Helwany, S. (2007). Applied soil mechanics with ABAQUS applications. John Wiley and Sons.
9. Das, B., and Ramana, G. V. (2010). Principles of soil dynamics. Cengage Learning.

CEL 552-CONSTRUCTION CONTRACTS AND SPECIFICATIONS   [(3-0-0); Credits: 3]

Course Objective:
To make Civil Engineering students able to analyze, evaluate and design construction contract documents.

Syllabus:
Construction Contract: Agreement, Contract, essential conditions, Indian Contract Act 1872, types of contract, terminology of contract.

Construction Specifications: Standard specifications, general specification, development, interpretation.

Tender and tender documents: Types of bidding, tender notice, tendering procedure.

Construction claims: Extra item, excess quantity, deficit quantity, price escalation.

Dispute resolution mechanism: Litigation, arbitration, conciliation, mediation, dispute resolution board.

Contractual Problems: possible contractual problems, creation of claims, development of disputes.

Contract document: Drafting of clauses, development, and interpretation, CPWD conditions of contract, FIDIC conditions of contract.

BOT contract: Types of contract, PPP framework, types of risk, concession agreement, drafting of clauses, development, and interpretation.

Laws affecting Engineers: Labour Law, Sales Tax, VAT, Service Tax, Excise Duty.

Relational Contract: Partnering, alliancing, key elements, processes.

Course Outcome:
1. Knowledge of types of construction contracts and their essential conditions.
2. Knowledge of standard specification.
3. Knowledge of the tendering procedure.
4. Knowledge of different dispute resolution mechanisms and laws.

REFERRENCE:
1. L.S. Ranaga Rao Contract Management and Dispute Resolutions Engineering staff College of India January 2008.
2. J. Schexnayder and R. E. Mayo,Construction Management Fundamentals,McGraw Hill, New Delhi.2003
3. General Conditions of Contract,Central Public Works Department, New Delhi,2010
4. S. Ranaga Rao,Contract Management & Dispute Resolutions,Engineering staff College of India,January 2008
5. D.S. Berrie and B.c. Paulson,Professional construction management including C.M.,Design construct and general contracting,McGraw Hill InternationaL,Third Edition 1992.
6. V. K. Raina,Construction & Contract Management Practices,SPD, New Delhi

AML 262 Mechanics of Solids   **[(3-0-0); Credits:3]**

Objective:
To introduce mechanical properties of materials. To introduce concepts of stress and strain. To introduce distribution of stresses & deformations.

Syllabus:

Mechanical Properties:
Concept of stress and strain, stress-strain behaviour of ductile and brittle material in uniaxial state of stress, elastic constants.

Axial Force, Shear Force and Bending Moment:
Determination of axial-force, shear force and bending moment at a section. Axial force diagram, shear force diagram and bending moment diagrams for simple determinate frames, differential relation between loads, shear force and bending moment.

Stresses in Beams:
Assumption and derivation of simple a bending theory, relation between bending moment, bending stress and curvature for homogeneous and composite beams. Shear stresses in simple beams, shear flow and shear stress distribution, Asymmetric bending.

Membrane Stresses:
Thin walled cylindrical and spherical pressured vessels subjected to internal pressure.

Torsion:
Torsion of circular sections, assumptions and derivation of relation between torsion moment, shear stress and angle of twist.

Combined Bending Moment and Axial Force:
Resultant normal stress due to combined effect of bending moment and axial force, eccentric loading, core section and its importance to masonry structure.

Transformation of stresses:
State of stress in two dimensions, State of stress in three dimensions, Principal stresses, Maximum shear stress, Use of Mohr's circle. Introduction to theories of failure

Deflection of Beams :
Derivation of differential equation of moment curvature relation, Deflection of simple beams by double integration method.

Columns and Struts:
Buckling of column, slenderness ratio, Euler's buckling load for slender column, effective length for different end condition.

Introduction to strain energy, Stresses due to Impact and concept of virtual work.

Method of Assessment:
Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:
1. Popov, E R. "Engineering Mechanics of solid", Prentice Hill of India, New Delhi, 2000.
2. Beer, Johnston, Dewolf. "Mechanics of Materials", Tata McGraw Hill, New Delhi, 2008.
3. Singer, F. L. "Strength of Materials", Harper Collins Publishers, Singapure, 1987.
4. Seely, F. B.; & Smith, J.O "Advanced Mechanics of Material", John Wiley & Sons. Inc.

AMP 262 – MECHANICS OF SOLIDS   **[(0-0-2); Credits: 1]**

1. Determination of stiffness of Tension Spring.
2. Tension Test on Mild Steel
3. Direct Shear Test on Bolts
4. Shear Strain due to Torsion
5. Torsion Test on Circular Shaft
6. Compression Stiffness of Closed Coiled Helical Spring.
7. Modulus of Rupture for Rectangular Wooden Beam
8. Determination of Flexural Rigidity of a Beam
9. Deflection of Beam
10. Study of Maxwell's reciprocal theorem
11. Principal stresses (Analytical / Graphical method)
12. Plotting stress contours /vectors
13. Deflection of Composite Beam

AML 361 – STRUCTURAL ANALYSIS   [(3-0-0); Credits 3]

Objective:
The objective of this subject is to expose students to various methods for structural analysis.

Syllabus:
Moment Area Method, Conjugate Beam Method, Analysis of fixed and continuous beams by theorem of three moments, effect of sinking of support.

Analysis of continuous beams and simple (non-sway) portal frames using Moment Distribution Method.

Rolling loads (including IRC) on simply supported beams with concentrated and uniformly distributed loads, maximum B.M. and S.F., Influence lines for reactions, bending moments and shear forces in simply supported beams, cantilevers and beams with overhangs, Influence lines for forces in members of simple trusses.

Strain energy method as applied to the analysis of redundant frames and redundant trusses up to two degrees.

Determination of deflection of trusses, Williot-Mohr diagram, Castigliano's theorem, Maxwell's reciprocal theorem, Betti's theorem.

Buckling of Column and beam-column, Euler's and Rankine's formula, Analysis of Two-Hinged arches, S.F. and normal thrust, parabolic arches.

Slope deflection method as applied to indeterminate beams & continuous beams, portal frames.

Course Outcome:
1. Able to analysis determinant and in-determinant structures
2. Able to understand Structural Responses
3. Able to analyseField problems of Structural analysis
4. Dessiminate knowledge of structuralAnalysis to society.
5. Communicate effectively the design parameters to the stakeholders.

REFERENCES:
1. Timoshenko S. P.; & Young D.H. "Theory of Structures", International edition, McGraw Hill, 1965.
2. Ghali, A. & Neville A. M. "Structural Analysis A Unified Classical and Matrix Approach (4th Edition)", E & FN SPON; Van Nostrand Reinhold, 1997.
3. Wang, C. K. "Indeterminate Structures", McGraw Hill International editions, 1983.
4. Schodek, D.L. "Structures (4th Edition)", Prentice Hall of India, 2000.
5. Meghre, A.S.; &Deshmukh, S.K. "Matrix Methods of Structural Analysis (1st Edition)", Anand, India; Charotar Publication, 2003.
6. Weaver, J. M. & Gere, W. "Matrix Analysis of Framed Structures (3rd edition)", Van NostrandReinhold;, New York, 1990.
7. Jain, O.P. & Arya, A.S. "Theory and Analysis of Structures; Vol. I & II", Nemchand Brothers; Roorkee.
8. KrishnamurthyD., "Theory of Structures", J.K. Jain Brothers, 1976.
9. RajsekaranS., Shankarasubramanian G. "Computational of StructuralMechanics", Prentice Hall of India Pvt. Ltd., New Delhi, 2001.

AMP 361 – STRUCTURAL ANALYSIS LABORATORY   **[(0-0-2); Credits: 1]**

Objective of the course is to have better understanding at structures & their responses to various loading. To enable students to determine forces, stresses, deflection and behavior of various structural members when subjected to different types of loading practically. This course will help students to apply their theoretical understanding learnt in the courses such as solid mechanics and structural analysis.

1. Study of Indeterminacy (static and dynamics) of structures.
2. Verification of Shear Force and Bending Moment Diagrams for Beams using standard structural analysis package.
3. Verification of Maxwell's reciprocal theorem.
4. Determination of Flexural Rigidity of a Beam.
5. Verification of Betti's theorem.
6. Study of Three Hinge Arch.
7. Verification of Three Moments Theorem using standard structural analysis package.
8. Verification of Moment Distribution Method using standard structural analysis package.
9. Verification of Strain Energy Method using standard structural analysis package.
10. Verification of Slope Deflection Method using standard structural analysis package.

AML 363 – DESIGN OF STEEL STRUCTURES   **[(3-1-0); Credits: 4]**

Course Objective:
The objective of this course is to introduce the students to the general design of tension, compression, beam members including connection, study of IS codes with latest design methods.

Syllabus:
Steel as a structural material: Various grades of structural steel, properties, various rolled steel sections (including cold formed sections, structural pipe (tube) sections) and their properties. Introduction to I.S. 800, 808, 816, 875, 1893 etc.; Design of axially loaded members: (a) Tension members (b) Compression members.

Design of roof truss: Load assessment for DL, LL and WL

Design of simple and built up beams: Laterally restrained and unrestrained, (symmetrical as well as unsymmetrical section). Curtailment of flange plates. Design of welded plate girder, concept of gantry girder. Design of single rolled steel section column subjected to axial load and biaxial moment including base design. Design of axially loaded built up columns. Laced and battened (Column

bases slab base gusseted base moment resistant bases)

Structural Fasteners: a) Behavior of bolted and welded connections (types, Designations, properties, permissible stresses), failure of bolted and welded joints. Strength of bolt and strength of weld. Efficiency of joints. Design of simple bolted and welded connections. (b) Moment resistant bolted and welded connection (bending and torsion).

Design of connection: Beam to beam, beam to column, framed connection. Seismic coefficient method [IS1893 (part I): 2002, seismic design and detailing of steel structures.

Course Outcome:
1. Capable of using all loading and limit state design methods for steel structures.
2. Capable of elementary design of tension /compression member.
3. Able to provide the design of beams, column base plates, plate girder.
4. Capable of understanding the types of structural fasteners and their behavior and connections.
5. Competent enough to analysis and design of steel structures and able to provide the good quality control during the steel construction.

REFERENCES:
1. Negi, B.S. "Design of Steel Structures", Tata McGraw Hill India, 1995.
2. Dayaratanam, P. "Design of Steel Structures", A.H. Wheeler & Co. Ltd.; Allahabad, 1990.
3. Ram Chandra. "Steel Structure Vol. I & II", Standard Publishers; Delhi.
4. Gaylords, E.H. &Gaylords, C. N. "Design of Steel Structures", McGraw Hill Publ, 1998.
5. Arya, A. S. &Ajmani, J.L. "Design of Steel Structures", Nemchand& Bros.; Roorkee, 1982.
6. N. Subramaniam, "Design of Steel Structures as per IS:800-2007", Oxford university press.
7. Shah & Gore, "Limit State Design of Steel Structures".

AML 461 – ADVANCED STRUCTURAL ANALYSIS   **[(3-1-0); Credits: 4]**

Course Objective:
The objectives of this course is to expose UG students to various methods of analysis of indeterminate structures and inter-relationship between the methods

Syllabus:
Kani's Method applied to symmetrical and unsymmetrical frames with sway (Up to single bay Two storey)

Moment Distribution applied to frames with sway correction, Approximate method of Structural analysis for multi-storied frames with lateral loads (Portal and Cantilever method), Approximate methods for vertical loads i.e. Substitute frame method etc. (Max three bay three storey)

Column Analogy method, Applications to beams, Calculations of Stiffness factors and carry over factors for non-prismatic members, Analysis of non-prismatic fixed beams.

Concept of static indeterminacy of structures, Formulation of Flexibility matrix and equations applied to simple trusses and continuous beams. Flexibility matrix for non-prismatic members.

Concept of kinematics indeterminacy of structures, Formulation of stiffness matrix and equations applied to simple trusses and continuous beams.

Stiffness matrix method applied to simple plane frames.

Course Outcome:
1. Able to choose method of analysis for indeterminate structure.
2. Able to understand stiffness method: structure as well as member approach.
3. Able to analyze non-prismatic beams.

REFERENCES:
1. Timoshenko S. P.; &Young D.H. "Theory of Structures; International edition", McGraw Hill, 1965.
2. Ghali, A.; & Neville A. M. "Structural Analysis A Unified Classical and Matrix Approach (4th Edition)", E & FN SPON; Van Nostrand Reinhold, 1997.
3. Wang, C. K. "Indeterminate Structures", Prentice Hall of India; 2000.
4. Schodek, D.L. "Structures (4th Edition)", McGraw Hill International editions; 1983.
5. Meghre, A.S.; &Deshmukh, S.K. "Matrix Methods of Structural Analysis (1st Edition)", Anand; CharotarPubls, 2003.
6. Weaver J.M.; & Gere, W. "Matrix Analysis of Framed Structures (3rd edition)", Van Nostrand Reinhold; New York, 1990.

AML 462 - ELEMENTS OF STRUCTURAL DYNAMICS & EARTHQUAKE ENGINEERING
[(3-0-0); Credits: 3]

Course Objective:
1. Introduction to the concept of damped and undamped system.
2. Introduction to the concept of earthquake and its origin.
3. Introduction to IS 1893
4. Introduction to the concept of Multi-degree-of-freedom.

Syllabus:
Undamped and damped Single Degree of Freedom System (SDOF), Equation of motion, Natural frequency, Logarithmic Decrement

Response of SDOF to Harmonic Loading, Response of SDOF to arbitrary loading; Impulse response, Duhamel integral, Concept of Response Spectra

Origin of earthquakes, Engineering geology, Seismicity of the world, Faults, Propagation of earthquake waves, Quantification of earthquake (magnitude, energy, intensity of earthquake), Measurements of earthquake (accelerograph, accelogram recording)

IS 1893: Equivalent Static Analysis, Regular Irregular buildings, Torsion provision, Four virtues of EQRD: Stiffness, Strength, ductility and Configurations, Introduction to Capacity design concepts

Introduction to Multi-degree-of-freedom (MDOF) system, Mode shapes, Response Spectrum Method of IS 1893, Modal Combination Rule, SRSS.

Concept of ductility, provisions of IS 13920

Course Outcome:
1. Knowledge of concept of damped and un-damped system.
2. Understanding the concept of earthquake and its origin.
3. Knowledge of IS 1893 and multi-degree-of-freedom.

REFERENCE:
1. Kramer, S.L. *Geotechnical Earthquake Engineering*; Prentice Hall; New Jersey; 1996.
2. Agarwal P. and Shrikhande M., *Earthquake Resistant Design of Structures*, Prentice-Hall of India, New Delhi, 2008.
3. Chopra A. K., *Dynamics of Structures*: *Theory and Applications to Earthquake Engineering*, Prentice-Hall of India, New Delhi, 1998.
4. IS 1893, "Criteria for Earthquake Resistant Design of Structures (Part 1): General Provisions and buildings", Bureau of Indian Standard; New Delhi, 2002.
5. IS 13920, "Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice", Bureau of Indian Standard; New Delhi, 1993

AML 525- Design of Advanced Steel Structures [(3-0-0); Credits:3]

Objective:
To design the structures used for works shop building foot bridges, road bridge study of IS codes.

Syllabus:
Introduction to Allowable Stress Design, Plastic design

Loadings as per IRC, IRS, IS (IS:800, IS:875 part 1-V, IS:1893) applicable to various steel structures.

Design of Beam-column, Plate Girders, Open web structures and Space structures.

Bridges, Industrial Buildings including crane girders.

Welded and riveted connections.

Method of Assessment:
Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:
1. Owens, G.W. & Knowles, P.R. "Steel Designers Manual", Blackwell, 1994.
2. Gaylords, E.H. & Gaylords, C. N. "Design of Steel Structures", McGraw Hill Publ, 1998.
3. "Steel Design Manual", ELBS and Granada Publishers; London.
4. Johnson, R.P. "Composite Structures of Steel and Concrete; Vol-I", Granado Publishing Ltd.; London; 1975.
5. Salmon and Johnson. "Steel Structures – Design and Behaviour", Harper and Collins Publishers.

AML424 – STRUCTURAL DYNAMICS   **[(3-0-0); Credits: 3]**

Course Objective:
The objective of this subject is to expose student to understand the basic theory of structural dynamics, structural behavior under vibratory load and the effect of damping.

Syllabus:
Sources of vibration, types of excitations, Principle and working of piezoelectric transducers, Spring action and damping; Degrees of freedom; Application of Newton's laws, D'Alembert's principle, Single degree of freedom systems; Mathematical model of physical systems; Free vibrations of undamped and viscously damped systems; Coulomb damping material and radiation damping.

Response of viscously damped SDOF systems to harmonic excitation; Vibration Isolation, Force transmissibility and base motion; Principle of vibration measuring instruments; Equivalent viscous damping; structural damping, Response of an undamped SDOF to short duration impulse; unit impulse response. Response of undamped system of rectangular, triangular and ramp loading; response to general dynamic excitation.

Duhamel integral method. Response spectra, Numerical evolution of dynamic response of linear systems, Frequency domain analysis, Fast Fourier Transform

Multiple degree of Freedom system, Vibration of undamped 2 DOF systems; Response of 2 DOF to harmonic excitation, mode superposition, vibration absorber, Lagrange equation and their application to lumped parameter models of MDOF (up to 3 DOF). Free vibration of MDOF (up to 3 DOF) systems, methods of solving eigen value problems; iteration methods.

Dynamic response of MDOF (2 DOF) systems-modal superposition method. Vibration of Continuous Systems, Free vibrations of Continuous systems-axial and transverse vibration of bars / beams. Response of continuous systems to dynamic loads.

Energy Principle, Rayleigh-Ritz method.

Course Outcome:
1. Convert structure into SDOF system.
2. Find response of free and force vibration (harmonic, periodic and transient) of SDOF system.
3. Find natural frequency and mode shapes of MDOF system.
4. Carry out modal analysis of MDOF system.
5. Perform experiments and computer simulation of vibrating system.

REFERENCES:
1. Chopra, A.K., "Dynamics of Structures", Prentice Hall, 3rd Edition, NY, 1970.
2. Clough, R.W. &Penzin, J., "Dynamics of Structures", McGraw Hill, 1993.
3. Humar, J.L., "Dynamics of Structures", Prentice Hall, 1990.
4. Mario, Paz, "Structural Dynamics", CBS Publ. N-Delhi, 1995.
5. Timoshenko, S., "Advanced Dynamics", McGraw Hill Book Co, NY, 1948.
6. Meirovitch, L., "Elements of Vibration Analysis", 2nd Edition, McGraw Hill International Edition, Singapore, 1986.
7. Biggs, J.M., "Introduction of Structural Dynamics", McGraw Hill, NY, 1964.

AML 467 – ADVANCED RCC   **[(3-1-0); Credits: 4]**

Course Objective:
The objective of this course is to expose the students to the application of basic design procedures to the design of important structures such as bridges, multistoried buildings and water tanks.

Syllabus:
Approximate analysis and design of building frames, Calculation of loads due to Dead load, Live load, Wind load, Earthquake loads (Codal co-efficient method only) on multistoried frames as per relevant IS codes, Design of elements of multistoried frames such as beams, columns, foundations etc., detailing of structures as per IS: 456 & IS: 13920.

Analysis and design of rectangular and circular tanks (Underground, on-ground and elevated) using coefficients given in IS: 3370, Analysis and design of staging for static, wind and earthquake forces, Design of foundations for ESRs.

Analysis and design of slab type bridges subjected to various types of IRC loads, Analysis and design of T-beam bridges (limited to two girders, simply supported ends) with load distribution as per Courbon's method.

Course Outcome:
1. Design a building from foundation to roof level.
2. Read structural drawings of RCC building.
3. Understand seismic analysis, design and detailing of building.
4. Design water tanks on ground surface, underground tank and overhead tank.
5. Design small bridges.

REFERENCES:
1. Jain, O.P.; &Jaikrishna, "Plain and Reinforced Concrete (Vol-I&II)", NemChnand& Bros; Roorkee.
2. Varghese, P. C., "Advanced Reinforced Concrete Structures", Prentice Hall of India, 2000.
3. Pillai, S.U.; & Menon, D., "Reinforced Concrete Design", Tata McGraw Hill Publishing company ltd. India, 1998.
4. "IS: 456; Code for Practice: Plain and Reinforced Concrete", Bureau of Indian standards; New Delhi, 2000.
5. "IS: 875 (Part 1 to 4); Code for Practice for Design Loads (Other than Earthquake) For Buildings & Structures; Second Revision (5th Reprint)", Bureau of Indian Standards; New Delhi, 1987.
6. "IS: 1893 (Part-1); Criteria for Earthquake Resistant Design of Structures; (5th Edition)", Bureau of Indian Standards; New Delhi, 2002.
7. "IS: 13920; Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- code of Practice; Second reprint-1996", Bureau of Indian Standards; New Delhi, 1993.
8. "SP- 16; Design Aids for Reinforced Concrete to IS- 456", 1980.
9. "SP- 34; Handbook on Concrete Reinforcement & Detailing and other relevant codes", 1987.

MAL203 NUMERICAL METHODS AND COMPUTATION   **[(3-0-1); Credits: 4]**

Course Objective:
The objective of this subject is to make the students aware of the numerical methods for the solution of scientific problems which cannot be solved analytically.

Syllabus:
Interpolation: Existence, Uniqueness of interpolating polynomial, error of interpolation, unequally spaced data, Lagrange's formula, and Newton's divided difference formula. Equally spaced data, finite difference operators and their properties, Gauss's forward and backward, Sterling's formulae - Inverse interpolation - Hermite interpolation.

Differentiation: Finite difference approximations for first and second order derivatives.

Integration: Newton-cote type closed methods, particular cases, error terms; Newton-cotes open type methods, Romberg integration, Gaussian quadrature, Legendre Formulae.

Solution of non-linear and transcendental equations: Regula Falsi method, Newton-Raphson method, Newton Raphson method for system of non-linear equations.

Solution of linear algebric system equations: LU decomposition, Gauss-seidal methods; Solution of tridigonal system, III conditioned equation, Eigen values and Eigenvectors; Power and Jacobi methods.

Course Outcome:

The students should be able to solve scientific problems, which otherwise cannot be solved analytically using numerical methods.

REFERENCE:
1. Jain, Jyengar and Jain, Numerical Methods for Engineers and Scientists, Wiley Estern.
2. S. D. Cante and C. de Boor, Elementary Numerical Analysis, an algorithm approach, McGraw-Hill
3. Gerald and Wheatley, Applied Numerical Analysis, Addison-Wesley.
4. Aitkinson, Numerical Analysis, Jhon Wiley and Sons.

CEL 408 CONSTRUCTION SITE ADMINISTRATIONS AND CONTROL   **[(3-0-0); Credits: 3]**

Course Objective:
1. The course intends to equip the students with sufficient technical knowledge of job site layout planning.
2. To make the students aware with the various project delivery systems.

Syllabus:
Overview and Introduction to Indian Construction industry – Various sectors in Indian Construction Industry, Various reasons of project delays, Contribution of Indian Construction Industry towards the GDP, Project as a business.

Project Life Cycle – Understanding the project from concept to completion/closeout, Role of client/owner, consultant and contractor in different stages of the project.

Project delivery systems – Different Project delivery systems their merits and demerits, role of agencies and people involved in different project delivery systems.

Construction Site Management – Job Site Layout, Facilities Setup, Site Safety and accident prevention, documentation and record keeping, contract appreciation document for contract administration and coordination.

Field Procedure Manual (FPM) – Field Procedure Manual and its importance, Labor and subcontractor management, Site waste management, measurement and billing, project control estimate, and project escalations.

Project Communication – Meetings, review, inter & intra organizational relationships, Enterprise resource planning,

Case Studies – Construction project case studies.

Course Outcome:
At the completion of this course, students would be able to
1. Plan job site layout for any construction project
2. Overcome the factors affecting the project productivity
3. Make the project communication with various agencies involved in the project
4. Analyse the project escalations
5. Control construction project

REFERENCE:
1. Mincks, W. Johnston, H. (2011). Construction Jobsite Management. Delmar Cengage Learning, New York.
2. Ritz, G. (1994). Total Construction Project Management. McGraw-Hill, Singapore.
3. Jha, N. (2015). Construction Project Management: Theory and Practice, Pearson Education; 2 Edition, India.
4. Joy, P. (2007). Handbook of Construction Management. Macmillan India Limited, New Delhi.
5. Moore, D. (2001). Project Management – Designing Effective Organizational Structures in Construction. Blackwell Publishing, London.

CEL 429 Hydraulic Transients   **[(3-0-0); Credits: 3]**

Course Objectives:

1. To understand unsteady flow in pipelines

2. To know the methods of computation of water hammer

3. To understand the unsteady flow in channels

Syllabus:

Review of flow through pipe, Flow through pipe under variable head, Application of momentum equation for pipe bends

Unsteady flow in a pipe line for incompressible fluid, Time of flow establishment, Rigid water column theory of water hammer and computation of water hammer pressures

Water hammer phenomena when compressibility of fluid and elasticity of pipe is considered, computation of water hammer pressure of frictionless flow in horizontal pipe - for sudden and slow closure of valve, Application of Allievi's method for calculation of approximate pressures, Water hammer pressures in pumping systems

Computation of water hammer pressures in branched pipe system and in surge tank system, Devices used for protection from water hammer pressures, Function of surge tank and different type of surge tanks, Equations governing the flow in the simple surge tank system, Analysis of flow in a simple surge tank system, Computation of maximum surges in a simple surge tank, Case of hydraulic stability in a simple surge tank system, General arrangement of Hydropower project

Unsteady flow through channels, Gradually Varied Unsteady Flow (GVUF), Saint Venant Equations, Types of waves, Monoclinal rising wave, Unsteady Rapidly Varied Flow (URVF), Positive and Negative Surges, Wave velocities

REFERRENCE:

1. Streeter V.L. and Wyle E.B, Fluid Mechanics, Tata McGraw Hill Publication, 2005.

2. Ranga Raju, Flow through Open Channels, Tata McGraw Hill Publication 2004

3. Narsimhan S., Engineering Fluid Mechanics, Orient Longman Publication 1981

AML 364 Advanced Mechanics of Solids   **[(3-0-0); Credits: 3]**

Syllabus:

Buckling of Columns, Theory of Beam-column, Buckling of beam-column,

Beam on Elastic Foundation

Analysis of Thick Cylinders

Analysis of Three-Hinged arches, Analysis of cables, Three hinged suspension bridges, virtual work method for deformable bodies.

Stress-Strain Relation for Advanced Materials, Basics of Stress Tensors, Mohr's Circle in 3-D,

Theories of failure: Introduction, statement, significance and application of the theories of failure, Shear Centre.

Method of Assessment:
Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:
1. Stephen Timoshenko, Strength of Materials, Part 1, D. Van Nostrand Company, Incorporated.
2. Stephen Timoshenko, Strength of Materials, Part 2, D. Van Nostrand Company, Incorporated.
3. Den Hartog, J. P., Advanced Strength of Materials, Dover Publications
4. Advanced Strength and Applied Stress Analysis, Richard G. Budynas, 2nd Edition, McGraw Hill, 1999, ISBN: 978–0–07–008985–3.
5. Mechanics of Materials, Craig, R.R, 3rd Edition, John Wiley & Sons, 2011, ISBN: 978-0-470-48181-3

AML 365 Design of Masonry Structure   **[(3-0-0); Credits: 3]**

Objective:
To provide fundamental knowledge for designing various types of masonry structures.

Syllabus:

Material Properties: Masonry units- stones, brick and concrete blocks, hollow and solid units; Mortar, grout and reinforcement; various tests and standards.
Masonry Under Compression: Prism strength, Failure mechanism, types of construction and bonds; slenderness – effective length and effective height, effect of openings; code provisions.
Behavior of Masonry Structures: Common modes of failure, effect of unit shapes and mortar type, effect of roof and floor systems; Common deficiencies.
Analysis of masonry structures: Analysis for vertical and lateral loads, role of floor and roof diaphragm; Concept and design of bands, bandages, splints and ties; Reinforced masonry; Vertical reinforcement at corners and jambs; Measures in random-rubble masonry; Confined masonry; Code provisions.
Design of Masonry Building: Using IS code simplified provision; based on mathematical procedure.
Design of Masonry structures: Masonry chimneys; Industrial Masonry Sheds.
Retrofitting of Masonry Building: Techniques of repair and retrofitting of masonry buildings.

Method of Assessment:
Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:
1. Drysdale, R. G., Hamid, A. A., & Baker, L. R. (1994). Masonry structures: behavior and design. Prentice Hall.
2. Schneider, R. R., & Dickey, W. L. (1994). Reinforced masonry design. Pearson College Division.
3. Thomas, P., & Priestley, M. J. (1992). Seismic design of reinforced concrete and masonry buildings.
4. Hochwalt, J. M., &Amrhein, J. E. (2012). Reinforced Masonry Engineering Handbook.
5. Hendry, A. W. (1990). Structural masonry. Scholium International.
6. Tomazevic, M. (1999). Earthquake-resistant design of masonry buildings. World Scientific.
7. Anderson, D., &Brzev, S. (2009). Seismic design guide for masonry buildings. Canadian Concrete Masonry Producers Association.
8. IS 875 (Part 1-IV).
9. IS 1893 (Part 1). Criteria for Earthquake Resistant Design of Structures.
10. IS 4326.
11. IS 1905.
12. IS 13935
13. IITK BMTPC Eq. Tips

AML 468 Maintenance and Rehabilitation of Civil Engineering Structures   [(3-0-0); Credits: 3]

Objective: To understand various method for maintenance and rehabilitation of civil engineering structures

Syllabus:

Introduction:

Deterioration of structures. Definition, Need, & Classification of Maintenance. Common maintenance problems and Technology of maintenance.

Maintenance Works:

It's Incidence, Magnitude & Preventive Measures. Defects in construction and use of materials, choice of materials for durability and maintainability, Design, expose and other factors effecting durability. Inspection, Identification and diagnosis of Common defects and failures. Site selection, choice of structural systems and materials, specifications & detailing.)

Materials & Techniques for Maintenance:

Materials for repairs like cement, cement grouts, epoxy grouts, mortars and coatings, polymer concrete composites, sealants, membrane overlays, fiber reinforcement concrete, Resin based compounds, emulsions and paints, geotextiles. Techniques like stiffening, linings, guniting protection systems, prestressing, post-tensioning and base isolation technology. Temporary supporting system for Structures like timering, shoring etc.

Maintenance Planning, Design & Costing:

Policy formulation, standards of maintenance, Inspection cycles and condition surveys. Non-destructive evolution techniques. Planning & Design, Budgeting and controlling the cost of maintenance work. Reliability rating, Maintenance cost Records. Maintenance manuals, their function.

Rehabilitation/ Retrofitting: Techniques, Design & Costing

Strengthening of Existing Structures. Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass). Electro chemical repairs.

Research in to Maintenance:

Importance of research in areas of materials, techniques, field equipment and tools for investigation, repairs and monitoring non-destructive Evaluation techniques.

Case Studies.

Method of Assessment:

Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:

1. Building maintenance by Lvor H. Seeley; The Macmillan Press Ltd.
2. Facilities Maintenance and Repair of damaged structures by Karper. A Compilation of technical papers issued by Maharashtra India Chapter of American Concrete Institute.
3. Building maintenance economics and management, Edited by Alan Speeding, E & F. N. Spon, London.
4. Proceeding of the All India Seminar on Maintenance of Civil Engineering Structures and systems, Nagpur.
5. Common Building Defects, Diagnosis and Remedy, compiled by National Building agency, Construction press, London & New York.
6. Learning from Failures, Deficiencies in Design. Construction and Service, by R.N. Raikar, Structural Designers and Consultants Pvt. Ltd., New Bombay
7. I.R.C./B.I.S./C.B.R.I. Publication.
8. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf
9. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication
10. Concrete Repair, Rehabilitation and Retrofitting: M. Alexander, H. D. Beushausen, F.Dehn & P. Moyo, Taylor & Francis Publication
11. Concrete Repair Manual, Volume I & II, Published jointly by ACI, BRE, Concrete Society, ICRI.

AML 469 Basics of Finite Elements Method   **[(3-0-0); Credits: 3]**

Objective: To introduce concepts of finite element method and its use for structural analysis.

Syllabus:
General finite element solution procedure, Advantages and disadvantages of FEM, Basic ideas in a finite element solution, Compatibility, equilibrium and completeness requirements, Finite element equations using Rayleigh-Ritz method.

One-dimensional FEM: Linear spring, Expression for equivalent spring constant and nodal forces (parallel spring and springs in series), Local and global element equation for bar in x-y plane, computation of stress for bar in x-y plane, 1-D torsion of circular shaft, 1-D steady state heat conduction, 1-D flow through porous media, bar element and application to Trusses

Beam Element: Review of beam theory, Finite element formulation for beam element, Analysis of plane frames

Two-Dimensional FEM: Step by step formulation for CST element for 2-D, plane stress and plane strain problems, I

Introduction to Iso-parametric bar and 2-D elements

Computer implementation of FEM

Method of Assessment:
Assignments + Tutorials, Sessional Exam (I + II) and End Semester Exam

Reference:
1.P. N. Godbole, Introduction to Finite Element Methods, I K International Publishing House
2.Y. M. Desai, Finite Element Analysis and its Applications, University Printing Press, The University of Manitoba, Winnipeg, Manitoba, Canada (1996).
3.Robert D. Cook (Author), David S. Malkus, Michael E. Plesha, Robert J. Witt. Concepts and Applications of Finite Element Analysis, Wiley International.