SCHEME & SYLLABUS

OF

UNDERGRADUATE DEGREE COURSES IN CIVIL ENGINEERING

July 2018

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY
FARIDABAD

YMCA University of Science and Technology, Faridabad

(A Haryana State Government University)

(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22 to Confer Degrees)

VISION

YMCA University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the-art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

Program Educational Objectives (PEO'S)

PEO-1:
A fundamental knowledge of the basic and engineering sciences and develop mathematical and analytical skills required for civil engineering.

PEO-2:
Graduates to be equipped with practical skills and experimental practices related to core and applied areas of civil engineering to expand their knowledge horizon beyond books. This will prepare the students to take-up career in industries or to pursue higher studies in civil and interdisciplinary programs.

PEO-3:
Graduates will have improved team building, team working and leadership skills with high regard for ethical values and social responsibilities.

PEO- 4:
Civil Graduates will explore and create innovations in various aspects of engineering.

PROGRAMME OUTCOMES (PO'S) B.TECH. CIVIL ENGINERING

Engineering Graduates will be able to:

1) Engineering knowledge: Apply knowledge of mathematics, science, engineering fundamentals, and civil engineering to the solution of engineering problems.

2) Problem analysis: Identify, formulate, review literature and analyze civil engineering problems to design, conduct experiments, analyze data and interpret data.

3) Design /development of solutions: Design solution for civil engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations.

4).Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in civil engineering.

5) Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to civil engineering activities with an understanding of the limitations.

6) The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to civil engineering practice.

7) Environment and sustainability: Understand the impact of the civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.

8) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice.

9) Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in civil engineering.

10) Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in civil engineering.

11) Project Management and finance: Demonstrate knowledge & understanding of the civil engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in civil engineering.

12) Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in civil engineering.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1) To apply practical skills, knowledge of engineering fundamentals and civil engineering, to industries and institutions.

2) To explore, create and develop innovations in various aspects of engineering. The student will be ready to take-up career or to pursue higher studies with high regard to ethical values and social responsibilities.

GRADING SCHEME

Marks %	Grade	Grade points	Category
90-100	O	10	Outstanding
80≤marks<90	A+	9	Excellent
70≤marks< 80	A	8	Very good
60≤marks< 70	B+	7	Good
50≤marks< 60	B	6	Above average
45≤marks< 50	C	5	Average
40≤marks< 45	P	4	Pass
<40	F	0	Fail
	Ab	0	Absent

Percentage calculation= CGPA * 9.5

Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
PROJ	Project

Undergraduate Degree Courses in Engineering & Technology

CIVIL ENGINEERING

(As per guidelines of All India Council for Technical Education Model curriculum)

1. General, Course structure & Theme &Semester-wise credit distribution

Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week 2 Hours Practical (Lab) per week	0.5 credits 1 credit

Credits - 160 for a student to be eligible to get Under Graduate degree in Engineering.

Structure of Undergraduate Engineering program:

S. No.	Category	Breakup of Credits
1	Humanities and Social Sciences including Management courses	11
2	Basic Science Courses	24
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	30
4	Professional core courses	48
5	Professional Elective courses relevant to chosen specialization/branch	23
6	Open subjects – Electives from other technical and /or emerging subjects	09
7	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	15
8	Mandatory Courses [Environmental Sciences, Indian Constitution]	(non-credit)
	Total	160

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

Sl. No	Code No.	Subject	Semester	Credits
1.	HSMC101	English	II	3
2.	HSMC251	Introduction to Civil Engineering	III	3
3.	HSMC01	Humanities-I (Effective Technical Communication)	III	3
4.	HSMC252	Civil Engineering - Societal & Global Impact	IV	2
			Total Credits:	**11**

BASIC SCIENCE COURSES

Sl. No	Code No.	Subject	Semester	Credits
1.	BSC101	Physics (Mechanics & Mechanics of Solids)	I	5.5
2.	BSC103	Mathematics –I (Calculus, Multivariable Calculus and Linear Algebra)	I	4
3.	BSC 102	Chemistry-I	II	5.5
4.	BSC 104	Mathematics –II (Differential Equations)	II	4
5.	BSC 01	Biology	III	3
6.	BSC225	Life Science	III	2
			Total Credits:	**24**

ENGINEERING SCIENCE COURSES

Sl. No	Code No.	Subject	Semester	Credits
1.	ESC101	Basic Electrical Engineering	I	5
2.	ESC102	Programming for Problem Solving	II	5
3.	ESC104	Workshop Manufacturing Practices	II	3
4.	ESC105	Engineering Graphics & Design	I	3
5.	ESC201	Basic Electronics	III	3
6.	ESC203	Computer-aided Civil Engineering Drawing	III	2
7.	ESC205	Engineering Mechanics	III	4
8.	ESC212	Energy Science & Engineering	III	2
9.	ESC209	Mechanical Engineering	IV	3
			Total Credits:	**30**

PROFESSIONAL CORE COURSES/FUNDAMENTAL ENGINEERING PRINCIPLES & TOOLS

Sl. No	Code No.	Subject	Semester	Credits
1.	PCC-CE201	Instrumentation & Sensor Technologies for Civil Engineering Applications	IV	3
2.	PCC-CE202	Engineering Geology	IV	2
3.	PCC-CE203	Disaster Preparedness &Planning	IV	2
4.	PCC-CE204	Introduction to Fluid Mechanics	IV	3
5.	PCC-CE205	Introduction to Solid Mechanics	IV	2
6.	PCC-CE206	Surveying & Geomatics	IV	3
7.	PCC-CE207	Materials, Testing & Evaluation	IV	3
8.	PCC-CE301	Mechanics of Materials	V	3
9.	PCC-CE302	Hydraulic Engineering	V	4
10.	PCC-CE303	Structural Engineering	V	3
11.	PCC-CE304	Geotechnical Engineering	V	4
12.	PCC-CE305	Hydrology & Water Resources Engineering	V	3
13.	PCC-CE306	Environmental Engineering	V	3
14.	PCC-CE307	Transportation Engineering	V	3
15.	PCC-CE308	Construction Engineering & Management	VI	3
16.	PCC-CE309	Engineering Economics, Estimation & Costing	VI	4
			Total Credits:	**48**

PROFESSIONAL ELECTIVE COURSES

Sl. No	Code No.	Subject	Semester	Credits
1.	PEC-CEEL302	Elective-I	VI	3
2.	PEC-CEEL304	Elective-II	VI	3
3.	PEC-CEEL306	Elective-III	VI	3
4.	PEC-CEEL308	Elective-IV	VI	3
5.	PEC-CEEL401	Elective V	VII	3
6.	PEC-CEEL403	Elective-VI	VII	3
7.	PEC-CSEL402	Elective VII	VII	3
8.	PEC-CSEL402	Elective VIII	VII	2
			Total Credits:	**23**

OPEN ELECTIVE COURSES

Sl. No	Code No.	Subject	Semester	Credits
1.	OEEL302	Open Elective-I	VI	3
2.	OEEL401	Open Elective-II (Metro Systems & Engineering) – Suggested (See Annexure-I)	VI	3
3.	OEEL402	Open Elective-III	VII	3
			Total Credits:	**09**

Branch / Course: Civil Engineering
Total credits (4 year course) 160

Semester-wise structure of curriculum

[L= Lecture, T = Tutorials, P = Practicals & C = Credits]

First year credit=38
III to VIII Sem credit=122

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD
SCHEME OF STUDIES & EXAMINATIONS
B.TECH 2nd YEAR (SEMESTER – III) CIVIL ENGINEERING (2018-19)

Course No.	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits
		L	T	P	Total		Theory	Practical		
ESC201	Basic Electronics	3	0	0	3	25	75	-	100	3
BSC 01	Biology	3	0	0	3	25	75	-	100	3
ESC202	Engineering Mechanics	3	1	0	4	25	75	-	100	4
ESC212	Energy Science & Engineering	1	1	0	2	25	75	-	100	2
BSC225	Life Science	2	0	0	2	25	75	-	100	2
HSMC 01	Effective Technical Communication	3	0	0	3	25	75	-	100	3
HSMC251	Introduction to Civil Engineering	3	0	0	3	25	75	-	100	3
ESC203P	Computer-aided Civil Engineering Drawing Lab	0	0	4	4	15	-	35	50	2
	Total				**24**				**750**	**22**

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

SCHEME OF STUDIES & EXAMINATIONS

B.TECH 2nd YEAR (SEMESTER – IV) CIVIL ENGINEERING(2018-19)

Course No.	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits
		L	T	P	Total		Theory	Practical		
PCC-CE201	Instrumentation & Sensor Technologies for Civil Engineering Applications	2	0	-	2	25	75	-	100	2
PCC-CE202	Engineering Geology	2	0	- -	2	25	75	-	100	2
PCC-CE203	Disaster Preparedness &Planning	2	0	-	2	25	75	-	100	2
PCC-CE204	Introduction to Fluid Mechanics	2	0	-	2	25	75	-	100	2
PCC-CE205	Introduction to Solid Mechanics	2	0	-	2	25	75	-	100	2
PCC-CE206	Surveying & Geomatics	1	1	-	2	25	75	-	100	2
PCC-CE207	Materials, Testing & Evaluation	1	1	-	2	25	75	-	100	2
ESC209	Mechanical Engineering	2	1	-	3	25	75	-	100	3
PCC-CE201P	Instrumentation Lab	0	0	2	2	15		35	50	1
PCC-CE204P	Fluid Mechanics Lab	0	0	2	2	15		35	50	1
PCC-CE206P	Surveying Lab	0	0	2	2	15		35	50	1
PCC-CE207P	Materials Testing Lab	0	0	2	2	15		35	50	1
	Total				**25**				**1000**	**21**

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

SCHEME OF STUDIES & EXAMINATIONS

B.TECH 3rd YEAR (SEMESTER –V) CIVIL ENGINEERING (2018-19)

Course No.	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits
		L	T	P	Total		Theory	Practical		
PCC-CE301	Mechanics of Materials	2	1	-	3	25	75	-	100	3
PCC-CE302	Hydraulic Engineering	3	0	-	3	25	75	-	100	3
PCC-CE303	Structural Engineering	2	1	-	3	25	75	-	100	3
PCC-CE304	Geotechnical Engineering	3	0	-	3	25	75	-	100	3
PCC-CE305	Hydrology & Water Resources Engineering	2	1	-	3	25	75	-	100	3
PCC-CE306	Environmental Engineering	2	0	-	2	25	75	-	100	2
PCC-CE307	Transportation Engineering	2	0	-	2	25	75	-	100	2
MC CEFAE 03	Audit Course-1: Environment Science	3	-	-	3	-	-	-	-	0
PCC-CE302P	Hydraulic Engineering Lab			2	2	15		35	50	1
PCC-CE304P	Geotechnical Engineering Lab			2	2	15		35	50	1
PCC-CE307P	Transportation Engineering Lab			2	2	15		35	50	1
PCC-CE306P	Environmental Engineering Lab			2	2	15		35	50	1
	Total				**30**				**900**	**23**

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

SCHEME OF STUDIES & EXAMINATIONS

B.TECH 3rd YEAR (SEMESTER –VI) CIVIL ENGINEERING (2018-19)

Course No.	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits
		L	T	P	Total		Theory	Practical		
PCC-CE308	Construction Engineering &Management	2	1	-	3	25	75	-	100	3
PCC-CE309	Engineering Economics,Estimation & Costing	2	1	-	3	25	75	-	100	3
PEC-CEEL302	Elective-I	2	1	- -	3	25	75	-	100	3
PEC-CEEL304	Elective-II	3	0	-	3	25	75	-	100	3
OEEL302	Open Elective-I	3	0	-	3	25	75	-	100	3
PEC-CEEL306	Elective-III	3	0	-	3	25	75	-	100	3
PEC-CEEL308	Elective-IV	2	1	-	3	25	75	-	100	3
MC02	**Audit Course-II** Constitution of India	3	-	-	3	-	-	-	-	0
PROJ-CE301	Project-1*	0	0	2	2	15		35	50	1
PCC-CE309P	Engineering Economics, Estimation & Costing Lab			2	2	15		35	50	1
	Total				**28**				**800**	**23**

*Two presentations –midterm &end semester are mandatory.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

SCHEME OF STUDIES & EXAMINATIONS

B.TECH 4th YEAR (SEMESTER –VII) CIVIL ENGINEERING (2018-19)

Course No.	Course Title	Teaching Schedule				Marks for Sessional	Marks for End Term Examination		Total Marks	Credits
		L	T	P	Total		Theory	Practical		
PEC-CEEL401	Elective V	2	1	0	3	25	75	-	100	3
PEC-CEEL402	Elective-VI	2	1	0	3	25	75	-	100	3
PEC-CEEL403	Elective VII	2	0	0	2	25	75	-	100	2
PEC-CEEL404	Elective VIII	2	1	0	3	25	75	-	100	3
OEC401	Open Elective-II Suggested (Metro Systems &Engineering) See Annexure-I	3	0	-	3	25	75	-	100	3
OEC- 403	Open Elective-III	3	0	0	3	25	75	-	100	3
HSMC252	Civil Engineering - Societal & Global Impact	2	0	-	2	25	75	-	100	2
PROJ-CE402	Project-2* (Continued from VI Semester, Project work)	0	0	8	8	30		70	100	4
	Total				**27**				**800**	**23**

*Two presentations –midterm &end semester are mandatory.

YMCA UNIVERSITY OF SCIENCE AND TECHNOLOGY, FARIDABAD

SCHEME OF STUDIES & EXAMINATIONS

B.TECH 4th YEAR (SEMESTER – VIII) CIVIL ENGINEERING(2018-19)

Semester VIII (Fourth year]

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				L	**T**	**P**		
1	Industrial Training	PROJ - CE 403	Industrial Project training (Duration Full Semester)	0	0	20		10

In case student passes 20 credit through MOOC, he/she may be considered for the award of Under Graduate degree with Honours subject to the other eligibility criteria laid by YMCAUST.

PROFESSIONAL ELECTIVE COURSE TRACKS- CIVILENGINEERING [PEC-CE]

The following eight Mandatory Professional Specialized Tracks offer electives in the respective Tracks:

Track	Professional Core Courses (PCC-CE)
I	Transportation Engineering
II	Construction Engineering & Management
III	Environmental Engineering
IV	Hydraulics
V	Hydrology & Water Resources Engineering
VI	Structural Engineering
VII	Geotechnical Engineering
VIII	Concrete Structures

The students will have options of selecting the electives from the different tracks/threads depending on the specialization one wishes to acquire. **There may be at least two electives from the open elective course choices (OEC); the rest two can be taken from the other threads, if intended. This is provided in the following:**

Open Elective Courses[OEC]
Soft Skills and Interpersonal Communication
ICT for Development
Human Resource Development and Organizational Behavior
Cyber Law and Ethics
Introduction to Philosophical Thoughts
Comparative Study of Literature
Indian Music System
History of Science & Engineering
Introduction to Art and Aesthetics
Economic Policies in India
Metro Systems and Engineering

A list of 25 electives is also attached(OEC: 1-25).

I Transportation Engineering

1. Pavement Materials
2. Pavement Design
3. Public Transportation Systems
4. Traffic Engineering and Management
5. Urban Transportation Planning.
6. Geometric Design of Highways
7. Airport Planning and Design
8. Railway Engineering
9. Intelligent Transportation Systems
10. Pavement Construction and Management
11. Port and Harbour Engineering
12. High Speed Rail Engineering
13. Transportation Economics
14. Infrastructure Planning and Design

II Construction Engineering & Management

1. Construction Productivity
2. Building Construction Practice
3. Construction Project Planning&Systems
4. Construction Cost Analysis
5. Sustainable Construction Methods
6. Construction Engineering Materials.
7. Contracts Management
8. Construction Equipment& Automation
9. Repair & Rehabilitation of Structures

III Environmental Engineering

1. Ecological Engineering
2. Environmental Systems
3. Transport of Water and Wastewater
4. Environmental Laws and Policy
5. Physico-Chemical Processes for Water and Wastewater Treatment

6. Biological Processes for Contaminant Removal
7. Rural Water Supply and Onsite Sanitation Systems
8. Water and Air Quality Modelling
9. Solid and Hazardous Waste Management
10. Air and Noise Pollution and Control
11. Environmental Impact Assessment and Life Cycle Analyses
12. Sustainable Design Engineering & Technology

IV Hydraulics

1. Design of hydraulic structures/Irrigation Engineering
2. Pipeline Engineering
3. Unsteady Open Channel flow
4. River Engineering
5. Hydraulic modelling
6. Basics of computational hydraulics
7. Transients in closed conduits
8. Urban Hydrology and Hydraulics
9. Groundwater

V Hydrology & Water Resources Engineering

1. Water Quality Engineering
2. Surface Hydrology
3. Environmental Fluid Mechanics
4. Water Resources Field Methods

VI Structural Engineering

1. Reliability Analysis of Structures
2. Engineering Risk & Uncertainty
3. Decision and Risk Analysis
4. Engineering Materials for Sustainability
5. Concrete Materials
6. Wood Structures
7. Masonry Structures
8. Structural Analysis
9. Advanced Structural Analysis
10. Structural Analysis by Matrix Methods
11. Structural Mechanics
12. Reinforced Concrete
13. Concrete Technology
14. Design of Steel Structures
15. Metal Structure Behaviour
16. Bridge Engineering
17. Industrial Structures
18. Design of Structural Systems
19. Structural Dynamics
20. Earthquake Engineering
21. Civil Engineering Design
22. Geographic Information Systems and Science
23. Modelling and Analysis of Uncertainty
24. Systems Engineering & Economics

VII Geotechnical Engineering

1. Soil Mechanics
2. Foundation Engineering
3. Geotechnical Design
4. Structural Geology
5. Offshore Engineering
6. Rock Mechanics
7. Environmental Geo-technology
8. Ground Improvement Techniques

VIII Concrete Structures

1. Design of Concrete Structures
2. Prestressed Concrete

ESC- 201 BASIC ELECTRONICS ENGINEERING

B. Tech III Semester

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Physics

Successive: Mechatronics, Automation in Manufacturing

Course Objectives:

To provide an overview of electronic device components to Mechanical engineering students.

Course Contents:

Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

Digital Electronics Fundamentals :Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

Electronic Communication Systems: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the principles of semiconductor devices and their applications.
2. Design an application using Operational amplifier.
3. Understand the working of timing circuits and oscillators.
4. Understand logic gates, flip flop as a building block of digital systems.
5. Learn the basics of Electronic communication system.

Text /Reference Books:

1. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.
3. Frenzel, "Communication Electronics: Principles and Applications", Tata Mc Graw Hill, 3rd Edition, 2001

ESC203P	Computer-aided Civil Engineering Drawing	L:0T:4P	2 credits

The students will be able to

a) Develop Parametric design and the conventions of formal engineering drawing
b) Produce and interpret 2D & 3D drawings
c) Communicate a design idea/concept graphically/ visually
d) Examine a design critically and with understanding of CAD - The student learn to interpret drawings, and to produce designs using a combination of 2D and 3D software.
e) Get a Detailed study of an engineering artifact

ProposedSyllabus (No. of lectures shown within brackets)

Module 1:*INTRODUCTION***;** Introduction to concept of drawings, Interpretation of typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales; Introduction to computer aided drawing, co-ordinate systems, reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modify commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards.(2)

Module 2:*SYMBOLS AND SIGN CONVENTIONS*: Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards (2)

Module 3: *MASONRY BONDS:*English Bond and Flemish Bond – Corner wall and Cross walls - One brick wall and one and half brick wall (1)

Module 4: *BUILDING DRAWING*: Terms, Elements of planning building drawing, Methods of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity (7)

Module 5:*PICTORIAL VIEW*: Principles of isometrics and perspective drawing. Perspective view of building. Fundamentals of Building Information Modelling (BIM) (3)

Total 15 sessions

It may be advisable to conduct Theory sessions along with Lab demonstrations.

List of Drawing Experiments:

1. Buildings with load bearing walls including details of doors and windows. 09
2. Taking standard drawings of a typical two storeyed building including all MEP, joinery, rebars, finishing and other details and writing out a description of the Facility in about 500 -700 words. 06
3. RCC framed structures 09
4. Reinforcement drawings for typical slabs, beams, columns and spread footings. 09
5. Industrial buildings - North light roof structures - Trusses 06
6. Perspective view of one and two storey buildings 06

Total L: 15 + P: 45=60

Text/Reference Books:

1. Subhash C Sharma & Gurucharan Singh (2005), " Civil Engineering Drawing" , Standard Publishers
2. Ajeet Singh (2002), " Working with AUTOCAD 2000 with updates on AUTOCAD 200I", Tata- Mc Graw-Hill Company Limited, New Delhi
3. Sham Tickoo Swapna D (2009), " AUTOCAD for Engineers and Designers" , Pearson Education,
4. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD" , New Age International Pvt. Ltd.,
5. Balagopal and Prabhu (1987), " Building Drawing and Detailing", Spades publishing KDR building, Calicut,
6. (Corresponding set of) CAD Software Theory and User Manuals.
7. Malik R.S., Meo, G.S. (2009) Civil Engineering Drawing, Computech Publication Ltd New Asian.
8. Sikka, V.B. (2013), A Course in Civil Engineering Drawing, S.K.Kataria& Sons,

Goals & Outcomes:

The course should enable the students to

i) To develop graphical skills for communicating concepts, ideas and designs of engineering products graphically/ visually as well as understand another person's designs,

ii) and to get exposure to national standards relating to technical drawings using Computer Aided Design and Drafting practice

iii) Develop Parametric design and the conventions of formal engineering drawing

iv) Produce and interpret 2D & 3D drawings

v) Examine a design critically and with understanding of CAD - The student learn to interpret drawings, and to produce designs using a combination of 2D and 3D software.

vi) Develop drawings for conventional structures using practical norms.

ESC202	Engineering Mechanics	3L:1T:0P	4 credits

ESC-202 ENGINEERING MECHANICS

B. Tech III Semester

No. of Credits: 4
L T P Total
3 1 0 4

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Pre- Requisite: Physics, Mathematics

Successive: Kinematics of Machines, Dynamics of Machines, Strength of Materials

Course Objectives:

The objective of this Course is to provide an introductory treatment of Engineering Mechanics to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters.

Course Content:

Module 1: Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces,

Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static In-determinancy.

Module 2: Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

Module 3: Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines;

Module 4: Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Module 5: Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium.Applications of energy method for equilibrium. Stability of equilibrium.

Module 6: Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).

Module 7: Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

Tutorials from the above modules covering, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack

Course Outcomes:

Upon successful completion of the course, student should be able to:

CO 1- Understand the basic force system.

CO 2- Apply principles of particle kinematics.

CO 3- Grasp the concepts of particle dynamics.

CO 4- Learn energy methods & momentum methods.

CO5: Learn Principles of Virtual work

Text/Reference Books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics,

Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Upon successful completion of the course, student should be able to:

- Use scalar and vector analytical techniques for analysing forces in statically determinate structures
- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems
- Apply basic knowledge of maths and physics to solve real-worldproblems
- Understand measurement error, and propagation of error in processed data
- Understand basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts);
- Understand basic dynamics concepts – force, momentum, work and energy;
- Understand and be able to apply Newton's laws of motion.
- Understand and be able to apply other basic dynamics concepts - the Work-Energy principle, Impulse-Momentum principle and the coefficient of restitution;
- Extend all of concepts of linear kinetics to systems in general plane motion (applying Euler's Equation and considering energy of a system in general plane motion, and the work of couples and moments of forces)
- Learn to solve dynamics problems. Appraise given information and determine which concepts apply, and choose an appropriate solution strategy; and
- Attain an introduction to basic machine parts such as pulleys and mass-spring systems.

ESC212	Energy Science & Engineering	1L:1T:0P	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to provide *an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternative energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternatives, renewable energy sources such as solar, biomass (conversions), wind power, waves and tidal, geothermal, ocean thermal, hydro and nuclear. Energy conservation methods will be emphasized* from Civil Engineering perspective. The knowledge acquired lays a good foundation for design of various civil engineering systems/ projects dealing with these energy generation paradigms in an efficient manner.

Proposed Syllabus

Module 1*: Introduction to Energy Science:* Scientific principles and historical interpretation to *place ener*gy use in the context of pressing societal, environmental and climate issues; Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment

Module 2: *Energy Sources:* Overview of energy systems, sources, transformations, efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries).

Module 3:*Energy & Environment:* Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability; introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and research policy.

Module 4: *Civil Engineering Projects connected with the Energy Sources:* Coal mining technologies, Oil exploration offshore platforms, Underground and under-sea oil pipelines, solar chimney project, wave energy caissons, coastal installations for tidal power, wind mill towers; hydro power stations above-ground and underground along with associated dams, tunnels, penstocks, etc.; Nuclear reactor containment buildings and associated buildings, design and construction constraints and testing procedures for reactor containment buildings; Spent Nuclear fuel storage and disposal systems.

Module 5: *Engineering for Energy conservation:* Concept of Green Building and Green Architecture;Green building concepts (Green building encompasses everything from the choice of building materials to where a building is located, how it is designed and operated); *LEED ratings;* Identification of energy related enterprises that represent the breath of the industry and prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption

Text/Reference Books:

1. Boyle, Godfrey (2004), Renewable Energy (2nd edition). Oxford University Press
2. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press
3. Schaeffer, John (2007), Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaiam
4. Jean-Philippe; Zaccour, Georges (Eds.), (2005), Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, XVIII,
5. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A. (2006) Energy and the Environment, 2nd Edition, John Wiley
6. UNDP (2000), Energy and the Challenge of Sustainability, World Energy assessment
7. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company
8. Related papers published in international journals

Upon successful completion of the course, the students will be able to:

a) List and generally explain the main sources of energy and their primary applications nationally and internationally
b) Have basic understanding of the energy sources and scientific concepts/principles

behind them.

c) Understand effect of using these sources on the environment and climate
d) Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the impact on the environment.
e) List and describe the primary renewable energy resources and technologies.
f) To quantify energy demands and make comparisons among energy uses, resources, and technologies.
g) Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

HSMC201	Effective Technical Communication	3L:0T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.

Module 2: Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Hunan factors, Managing technical communication projects, time estimation, Single sourcing, Localization.

Module 3: Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, Taking notes; Complex problem solving; Creativity

Module 4: Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

Module 5: Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes,

Telephone Etiquettes, Engineering ethics, Managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, Taking notes, Complex problem solving, Creativity.

Text/Reference Books:

1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843)
3. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
4. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
5. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
6. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
7. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213)

HSMC251	Introduction to Civil Engineering	3L:0T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

When the students enter the college to pursue a degree in Civil Engineering and as well pursue a career in Civil Engineering after graduation, they need to understand the breadth and depth available in this field for possible engagement. When many alternative disciplines of engineering appear to offer apparently more glamourous avenues for advancement, the Civil Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all pervasive field of engineering.

This course is designed to address the following:

- to give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Civil Engineering
- to motivate the student to pursue a career in one of the many areas of Civil Engineering with deep interest and keenness.
- To expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

Proposed Syllabus

What is Civil Engineering/ Infrastructure, History of Civil Engineering, Overview of ancient & modern civil engineering marvels, current national planning for civil engineering/ infrastructure projects, scope of work involved in various branches of Civil Engineering – Architecture & Town planning, Surveying & Geomatics, Structural Engineering, Construction Management, Construction materials, Hydrology and Water Resources Engineering, Hydraulic Engineering, Environmental Engineering &Sustainability, Pavement

Engineering and construction, Traffic & Transportation Engineering and Management, Geotechnical Engineering, Ocean Engineering, Building Energy Efficiency, Basics of Contract Management, Professional Ethics, Avenues for entrepreneurial working, Creativity & Innovativeness in Civil Engineering,

Modules

1. **Basic Understanding**: What is Civil Engineering/ Infrastructure? Basics of Engineering and Civil Engineering; Broad disciplines of Civil Engineering; Importance of Civil Engineering, Possible scopes for a career
2. **History of Civil engineering**: Early constructions and developments over time; Ancient monuments & Modern marvels; Development of various materials of construction and methods of construction; Works of Eminent civil engineers.
3. **Overview of National Planning for Construction and Infrastructure Development**; Position of construction industry vis-à-vis other industries, five year plan outlays for construction; current budgets for infrastructure works;
4. **Fundamentals of Architecture & Town Planning**: Aesthetics in Civil Engineering, Examples of great architecture, fundamentals of architectural design & town planning; Building Systems (HVAC, Acoustics, Lighting, etc.); LEED ratings; Development of Smart cities
5. **Fundamentals of Building Materials**: Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals; Structural Steel, High Tensile Steel, Carbon Composites; Plastics in Construction; 3D printing; Recycling of Construction & Demolition wastes
6. **Basics of Construction Management & Contracts Management**: Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management
7. **Environmental Engineering & Sustainability**:Water treatment systems; Effluent treatment systems; Solid waste management; Sustainability in Construction;
8. **Geotechnical Engineering**: Basics of soil mechanics, rock mechanics and geology; various types of foundations; basics of rock mechanics & tunnelling
9. **Hydraulics, Hydrology &Water Resources Engineering**: Fundamentals of fluid flow, basics of water supply systems; Underground Structures; Underground Structures Multi-purpose reservoir projects
10. **Ocean Engineering**: Basics of Wave and Current Systems; Sediment transport systems; Ports & Harbours and other marine structures
11. **Power Plant Structures**: Chimneys, Natural & Induced Draught Colling towers, coal handling systems, ash handling systems; nuclear containment structures; hydro power projects
12. **Structural Engineering**: Types of buildings; tall structures; various types of bridges; Water retaining structures; Other structural systems; Experimental Stress Analysis; Wind tunnel studies;
13. **Surveying & Geomatics**: Traditional surveying techniques, Total Stations, Development of Digital Terrain Models; GPS, LIDAR;
14. **Traffic &Transportation Engineering**: Investments in transport infrastructure development in India for different modes of transport; Developments and challenges in integrated transport development in India: road, rail, port and harbour and airport sector;

PPP in transport sector; Intelligent Transport Systems; Urban Public and Freight Transportation; Road Safety under heterogeneous traffic; Sustainable and resilient pavement materials, design, construction and management; Case studies and examples.

15. **Repairs & Rehabilitation of Structures:** Basics of corrosion phenomena and other structural distress mechanisms; some simple systems of rehabilitation of structures; Non-Destructive testing systems; Use of carbon fibre wrapping and carbon composites in repairs.
16. **Computational Methods, IT, IoT in Civil Engineering:** Typical software used in Civil Engineering- Finite Element Method, Computational Fluid Dynamics; Computational Geotechnical Methods; highway design (MX), Building Information Modelling; Highlighting typical available software systems.

ORGANISATION OF COURSE (2-1-0)

S. No.	Module [No of Lectures within brackets]	Tutorials
1	Basic Understanding (1)	Develop a matrix of various disciplines and possible roles for engineers in each
2	History of Civil engineering (1)	Identify 10 ancient monuments and ten modern marvels and list the uniqueness of each
3	Overview of National planning for Construction and Infrastructure Development (1)	Develop a Strategic Plan for Civil Engineering works for next ten years based on past investments and identify one typical on-going mega project in each area
4	Architecture & Town Planning (1)	Identify ten best civil engineering projects with high aesthetic appeal with one possible factor for each; List down the possible systems required for a typical Smart City
5	Building Materials (2)	Identify three top new materials and their potential in construction; Visit a Concrete Lab and make a report
6	Construction Management, Contracts management (2)	Identify 5 typical construction methods and list their advantages/ positive features
7	Environmental Engineering & Sustainability (2)	Environmental Engineering & Sustainability: Sustainability principles, Sustainable built environment, water treatment systems, good practices of wastewater management. examples of Solid and hazardous waste management, Air pollution and control
8	Geotechnical Engineering (2)	List top five tunnel projects in India and their features; collect and study geotechnical investigation report of any one Metro Rail (underground) project; Visit a construction site and make a site visit report
9	Hydraulics, Hydrology &Water Resources Engineering (1)	Identify three river interlinking projects and their features; visit a Hydraulics Lab and make a report
10	Ocean Engineering, Ports & Harbours (1)	Identify 5 typical ports in India and list the structures available in them; Visit a related/similar facility, if possible in nearby place and make a report

11	Power Plant Structures (1)	Collect the typical layout for a large thermal power plant and a large hydro power plant and identify all the structures and systems falling in them.
12	Structural Engineering (3)	Identify 5 unique features for typical buildings,
		bridges, tall structures and large span structures; Visit Structures Testing Lab/facility and make a report
13	Surveying & Geomatics (1)	Collect visual representations prepared by a Total Station and LIDAR and compare; Study typical Google street map and Google Earth Map and study how each can facilitate the other
14	Traffic & transportation (1)	Investments in transport infrastructure; Developments and challenges; Intelligent Transport Systems; Smart Cities, Urban Transport; Road Safety; Sustainable and resilient highway design principles; Plan a sustainable transport system for a city; Identify key features/components in the planning and design of a green field highway/airport/port/railway and the cost – economics.
15	Repairs & rehabilitation of Structures (1)	Collect the history of a major rehabilitation project and list the interesting features
16	Computational Methods, IT, IoT in Civil Engineering (2)	Visit an AutoCad lab and prepare a report; Identify ten interesting software systems used in Civil Engg and their key features

Text/Reference Books:

1. Patil, B.S.(1974), Legal Aspects of Building and Engineering Contract
2. The National Building Code, BIS, (2017)
3. RERA Act, (2017)
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
5. Chandiramani, Neelima (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
6. Avtarsingh (2002), Law of Contract, Eastern Book Co.
7. Dutt (1994), Indian Contract Act, Eastern Law House
8. Anson W.R.(1979), Law of Contract, Oxford University Press
9. Kwatra G.K.(2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
10. Avtarsingh (2005), Law of Arbitration and Conciliation, Eastern Book Co.
11. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
12. P. S. Narayan (2000), Intellectual Property Rights, Gogia Law Agency
13. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
14. Bare text (2005), Right to Information Act
15. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
16. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act
17. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House

18. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss. 2, pp 117-127, MCB UP Ltd
19. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
20. Ethics in Engineering- M.W.Martin& R.Schinzinger, McGraw-Hill
21. Engineering Ethics, National Institute for Engineering Ethics, USA
22. www.ieindia.org
23. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
24. Resisting Bureaucratic Corruption: Alacrity Housing Chennai (Teaching Case Study) -S. Ramakrishna Velamuri -CEIBS
25. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm
26. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html
27. Contract &Agreements , http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm
28. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
29. Business & Personal Law. Chapter 7. "How Contracts Arise", http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
30. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt
31. IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS, http://www.worldbank.org/html/opr/consult/guidetxt/types.html
32. Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02), http://www.sandia.gov/policy/14g.pdf

Goals & Outcomes:

1. Introduction to what constitutes Civil Engineering
2. Identifying the various areas available to pursue and specialize within the overall field of Civil Engineering
3. Highlighting the depth of engagement possible within each of these areas
4. Exploration of the various possibilities of a career in this field
5. Understanding the vast interfaces this field has with the society at large
6. Providing inspiration for doing creative and innovative work
7. Showcasing the many monuments, heritage structures, nationally important infrastructure, and impressive projects to serve as sources of inspiration
8. Highlighting possibilities for taking up entrepreneurial activities in this field
9. Providing a foundation for the student to launch off upon an inspired academic pursuit into this branch of engineering.

BSC01	Biology	3L:0T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1. *(2 hours)- Introduction*

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry

Bring out the fundamental differences between science and engineering by drawing a

comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18^{th} Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2. *(3 hours)- Classification*
Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.
Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3. *(4 hours)-Genetics*
Purpose: To convey that " Genetics is to biology what Newton's laws are to Physical Sciences"
Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4. *(4 hours)-Biomolecules*
Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine
Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5. *(4 Hours). Enzymes*
Purpose: To convey that without catalysis life would not have existed on earth
Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6. *(4 hours)- Information Transfer*
Purpose: The molecular basis of coding and decoding genetic information is universal
Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and

recombination.

Module 7. *(5 hours). Macromolecular analysis*
Purpose: How to analyses biological processes at the reductionistic level
Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8. *(4 hours)- Metabolism*
Purpose: The fundamental principles of energy transactions are the same in physical and biological world.
Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of K_{eq} and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

Module 9. *(3 hours)- Microbiology*
Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

References:

1) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes
After studying the course, the student will be able to:

- Describe how biological observations of 18th Century that lead to major discoveries.
- Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Identify and classify microorganisms.

BSC225	Life Science	2L:0T:0P	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1A: *Plant Physiology* covering, Transpiration; Mineral nutrition *(3 Lectures)*

Module 1B: *Ecology* covering, Ecosystems- Components, types, flow of matter and energy in an ecosystem; Community ecology- Characteristics, frequency, life forms, and biological spectrum; Ecosystem structure- Biotic and a-biotic factors, food chain, food web, ecological pyramids; *(3 Lectures)*

Module 2A: *Population Dynamics* covering, Population ecology- Population characteristics, ecotypes; Population genetics- Concept of gene pool and genetic diversity in populations, polymorphism and heterogeneity; *(3 Lectures)*

Module 2B*: Environmental Management* covering, Principles: Perspectives, concerns and management strategies; Policies and legal aspects- Environment Protection Acts and modification, International Treaties; Environmental Impact Assessment- Case studies (International Airport, thermal power plant); *(3 Lectures)*

Module 3A*: Biotechnology* covering, Basic concepts: Totipotency and Cell manipulation; Plant & Animal tissue culture- Methods and uses in agriculture, medicine and health.

Module 4A: *Biostatistics* covering, Introduction to Biostatistics:-Terms used, types of data; Measures of Central Tendencies- Mean, Median, Mode, Normal and Skewed distributions; Analysis of Data- Hypothesis testing and ANNOVA (single factor) *(4 Lectures)*

Text/Reference Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

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4th Semester

PCC-CE201	**Instrumentation & Sensor Technologies for Civil Engineering Applications**	**1L:1T**	**2 credits**

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to understand instrumentation, sensor theory and technology, data acquisition, digital signal processing, damage detection algorithm, life time analysis and decision making. This course introduces theoretical and practical principles of design of sensor systems. Topics include: transducer characteristics for acoustic, current, temperature, pressure, electric, magnetic, gravity, salinity, concentration of contaminants, velocity, heat flow, and optical devices; limitations on these devices imposed by building/structure/pavement environments; signal conditioning and recording; noise, sensitivity, and sampling limitations; and standards. Lectures will cover the principles of state-of-the-art systems being used in physical infrastructure/bridges/buildings/pavements, etc. For lab work, the course will allow students to prepare, deploy and analyze observations from standard instruments. Laboratory experiments shall be used on application of concepts introduced in the lectures.

- Providing principle knowledge, practical training and measurement best practice for a range of temperature, pressure, electrical, velocity, acceleration and vibration systems

Proposed Syllabus

Module 1*: Fundamentals of Measurement, Sensing and Instrumentation covering* definition of measurement and instrumentation, physical variables, common types of sensors; Describe the function of these sensors; Use appropriate terminology to discuss sensor applications; and qualitatively interpret signals from a known sensor type, types of instrumentation, Sensor Specifics, Permanent installations, Temporary installations;

Module 2*: Sensor Installation and Operation covering to:* i) Predict the response of sensors to various inputs; ii) Construct a conceptual instrumentation and monitoring program; iii) Describe the order and methodology for sensor installation; and iv) Differentiate between types of sensors and their modes of operation and measurement and v) Approach to Planning Monitoring Programs, Define target, Sensor selection, Sensor siting, Sensor Installation & Configuration, Advanced topic, Sensor design, Measurement uncertainty

Module 3*: Data Analysis and Interpretation covering* a) Fundamental statistical concepts, b) Data reduction and interpretation, c) Piezometer, Inclinometer, Strain gauge, etc. d) Time domain signal processing, e) Discrete signals, Signals and noise and f) a few examples of statistical information to calculate are: Average value (mean), On average, how much each measurement deviates from the mean (standard deviation), Midpoint between the lowest and highest value of the set (median), Most frequently occurring value (mode), Span of values over which your data set occurs (range)

Module 4*: Frequency Domain Signal Processing and Analysis covering* Explain the need for frequency domain analysis and its principles; Draw conclusions about physical processes based on analysis of sensor data; Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform, FFT (Fast Fourier Transform), Example problems: Noise reduction with filters, Leakage, Frequency resolution

Tutorials*from the above modules* demonstrating clearly the understanding and use for the sensors and instruments used for the problems posed and inferences drawn from the measurement and observations made along with evaluation report

PCC-CE201P	Instrumentation Lab , P=2hr, I Credit

Practicals:

Instrumentation of typical civil engineering members/structures/structural elements
Use of different sensors, strain gauges, inclinometers,
Performance characteristics
Errors during the measurement process
Calibration of measuring sensors and instruments
Measurement, noise and signal processing
Analog Signal processing
Digital Signal Processing
Demonstration & use of sensor technologies

Text/Reference Books:

1. Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann
2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press
3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis
4. Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer

What will I learn?

- Understand the principles of operation and characteristics of instrumentation and integrated sensor systems
- Understand right use of sensors and instruments for differing applications along with limitations
- Recognize and apply measurement best practice and identify ways to improve measurement and evaluation
- Troubleshoot and solve problems in instrumentation and measurement systems
- To instill and encourage a questioning culture

Outcomes:

- To analyze the errors during measurements
- To specify the requirements in the calibration of sensors and instruments
- To describe the noise added during measurements and transmission
- To describe the measurement of electrical variables
- To describe the requirements during the transmission of measured signals
- To construct Instrumentation/Computer Networks
- To suggest proper sensor technologies for specific applications
- To design and set up measurement systems and do the studies

PCC-CE202	Engineering Geology	2L:0T	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to focus on the core activities of engineering geologists – site characterization and geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock and unconsolidated materials in the characterization of geologic sites for civil work projects and the quantification of processes such as rock slides, soil-slope stability, settlement, and liquefaction.

Engineering geology is an applied geology discipline that involves the collection, analysis, and interpretation of geological data and information required for the safe development of civil works. Engineering geology also includes the assessment and mitigation of geologic hazards such earthquakes, landslides, flooding; the assessment of timber harvesting impacts; and groundwater remediation and resource evaluation. Engineering geologists are applied geoscientists with an awareness of engineering principles and practice—they are not engineers.

Proposed Syllabus:

Module 1: Introduction-Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Department dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM. Mineralogy-Mineral, Origin and composition. Physical properties of minerals, susceptibility of minerals to alteration, basic of optical mineralogy, SEM, XRD., Rock forming minerals, megascopic identification of common primary & secondary minerals.

Module 2: Petrology-Rock forming processes. Specific gravity of rocks. Ternary diagram. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Concept of Hot spring and Geysers. Characteristics of different types of magma. Division of rock on the basis of depth of formation, and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. IUGS Classification of phaneritic and volcanic rock.. Field Classification chart. Structures. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Metamorphic Aureole, Kaolinization. Landform as Tors. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite, Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone and Shale, Limestone Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Schistosity, Foliation. Classification. Detailed study of Gneiss, Schist, Slate with engineering consideration.

Module3: Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Engineering consideration. Superficial deposits and its geotechnical importance: Water fall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, Solifluction deposits, mudflows, Coastal deposits.

Module 4:Strength Behavior of Rocks- Stress and Strain in rocks. Concept of Rock Deformation & Tectonics. Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Main types of discontinuities according to size. Fold- Types and nomenclature, Criteria for their recognition in field. Faults: Classification, recognition in field, effects on outcrops. Joints & Unconformity; Types, Stresses responsible, geotechnical importance. Importance of structural elements in engineering operations. Consequences of failure as land sliding, Earthquake and Subsidence. Strength of Igneous rock structures.

Module 5: Geological Hazards- Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. . Types of landslide. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment. Case study on black clay. Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of water table and Subsidence. Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Revelation from Seismic Records of structure of earth. Seismic Zone in India.

Module 6: Rock masses as construction material: Definition of Rock masses. Main features constituting rock mass. Main features that affects the quality of rock engineering and design. Basic element and structures of rock those are relevant in civil engineering areas. Main types of works connected to rocks and rock masses. Important variables influencing rock properties and behavior such as Fresh rock Influence from some minerals. Effect of alteration and weathering. Measurement of velocity of sound in rock.

Module 7: Geology of dam and reservoir site- Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment giving to such structures.

Demonstration :

i. Study of physical properties of minerals.
ii. Study of different group of minerals.
iii. Study of Crystal and Crystal system.
iv. Identification of minerals: Silica group: Quartz, Amethyst, Opal; Feldspar group: Orthoclase, Plagioclase; Cryptocrystalline group: Jasper; Carbonate group: Calcite; Element group: Graphite; Pyroxene group: Talc; Mica group: Muscovite; Amphibole group: Asbestos, Olivine, Hornblende, Magnetite, Hematite, Corundum, Kyanite, Garnet, Galena, Gypsum.
v. Identification of rocks (Igneous Petrology): Acidic Igneous rock: Granite and its varieties, Syenite, Rhyolite, Pumice, Obsidian, Scoria, Pegmatite, Volcanic Tuff. Basic rock: Gabbro, Dolerite, Basalt and its varieties, Trachyte.
vi. Identification of rocks (Sedimentary Petrology): Conglomerate, Breccia, Sandstone and its varieties , Laterite, Limestone and its varieties, Shales and its varieties.
vii. Identification of rocks (Metamorphic Petrolody): Marble, slate, Gneiss and its varieties, Schist and its varieties. Quartzite, Phyllite.

Text/Reference Books:

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons.
2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India.
3. Geology for Geotechnical Engineers, J.C.Harvey, Cambridge University Press (1982).

What will I learn?

Students will be able to:

- Use suitable software to examine geology, soil, geologic hazard, and NEHRP data to characterize a geologic site.
- Calculate the bulk properties of rocks and unconsolidated sediments such as density, void ratio, water contents, and unit weights.
- Evaluate rock-mass quality and perform a kinematic analysis.
- Apply the factor of safety equation to solve planar rock slide and toppling problems.
- Perform a grain-size analysis, determine plastic and liquid limits, and classify soils using the Unified Soil Classification System.
- Calculate soil consolidation magnitudes and rates under induced stress conditions.
- Determine soil strength parameters from in situ tests.
- Apply the method of slices and factor of safety equation to solve rotational slide problems.

Outcomes:

Students will understand:

i) Site characterization and how to collect, analyze, and report geologic data using standards in engineering practice
ii) The fundamentals of the engineering properties of Earth materials and fluids.
iii) Rock mass characterization and the mechanics of planar rock slides and topples.
iv) Soil characterization and the Unified Soil Classification System.
v) The mechanics of soils and fluids and their influence on settlement, liquefaction, and soil slope stability.

PCC-CE203	Disaster Preparedness & Planning Management	1L:1T:0P	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The overall aim of this course is to provide broad understanding about the basic concepts of Disaster Management with preparedness as a Civil Engineer. Further, the course introduces the various natural hazards that can pose risk to property, lives, and livestock, etc. and understanding of the social responsibility as an engineer towards preparedness as well as mitigating the damages.

The objectives of the course are i) To Understand basic concepts in Disaster Management ii) To Understand Definitions and Terminologies used in Disaster Management iii) To Understand Types and Categories of Disasters iv). To Understand the Challenges posed by Disasters vi) To understand Impacts of Disasters Key Skills

Proposed Syllabus

Module 1: Introduction - Concepts and definitions: disaster, hazard, vulnerability, risks-severity, frequency and details, capacity, impact, prevention, mitigation).

Module 2:Disasters - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

Module 3:Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

Module 4: Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Module 5: Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

Text/Reference Books:

1. http://ndma.gov.in/ (Home page of National Disaster Management Authority)
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
6. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003
7. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

Outcomes:

The student will develop competencies in

- the application of Disaster Concepts to Management
- Analyzing Relationship between Development and Disasters.
- Ability to understand Categories of Disasters and
- realization of the responsibilities to society

PCC-CE204	Introduction to Fluid Mechanics	2L:0T	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this course is to introduce the concepts of fluid mechanics useful in Civil Engineering applications. The course provides a first level exposure to the students to fluid statics, kinematics and dynamics. Measurement of pressure, computations of hydrostatic forces on structural components and the concepts of Buoyancy all find useful applications in many engineering problems. A training to analyse engineering problems involving fluids – such as those dealing with pipe flow, open channel flow, jets, turbines and pumps, dams and spillways, culverts, river and groundwater flow - with a mechanistic perspective is essential for the civil engineering students. The topics included in this course are aimed to prepare a student to build a good fundamental background useful in the application-intensive courses covering hydraulics, hydraulic machinery and hydrology in later semesters.

Module 1: Basic Concepts and Definitions – Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

Module 2: Fluid Statics - Fluid Pressure: Pressure at a point, Pascals law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Micromanometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

Module 3: Fluid Kinematics- Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three -dimensional continuity equations in Cartesian coordinates

Module 4: Fluid Dynamics- Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation : venturimeter, orifice meter and pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Dimensional Analysis and Dynamic Similitude - Definitions of Reynolds Number, Froude Number, Mach Number, Weber *Number and Euler Number; Buckingham's* π-Theorem.

Text/Reference Books:

1. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010
2. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
3. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
4. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill.

At the end of the course, the student will be able to:

- Understand the broad principles of fluid statics, kinematics and dynamics
- Understand definitions of the basic terms used in fluid mechanics
- Understand classifications of fluid flow
- Be able to apply the continuity, momentum and energy principles
- Be able to apply dimensional analysis

PCC-CE204P	Fluid Mechanics Lab

P- 02 Hours: 1 Credit

Lab Experiments

1. Measurement of viscosity
2. Study of Pressure Measuring Devices
3. Stability of Floating Body
4. Hydrostatics Force on Flat Surfaces/Curved Surfaces
5. Verification of Bernoulli's Theorem
6. Venturimeter
7. Orifice meter
8. Impacts of jets
9. Flow Visualisation -Ideal Flow
10. Length of establishment of flow
11. Velocity distribution in pipes
12. Laminar Flow

PCC-CE205	Introduction to Solid Mechanics	2L:0T:0P	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to introduce to continuum mechanics and material modelling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design. The overarching theme is a unified mechanistic language using thermodynamics, which allows understanding, modelling and design of a large range of engineering materials. The subject of mechanics of materials involves analytical methods for determining the strength, stiffness (deformation characteristics), and stability of the various members in a structural system. The behaviour of a member depends not only on the fundamental laws that govern the equilibrium of forces, but also on the mechanical characteristics of the material. These mechanical characteristics come from the laboratory, where materials are tested under accurately known forces and their behaviour is carefully observed and measured. For this reason, mechanics of materials is a blended science of experiment and Newtonian postulates of analytical mechanics.

Proposed Syllabus

Module1: *Simple Stresses and Strains*- Concept of stress and strain, St. Venant's principle, stress and strain diagram,Elasticity and plasticity – Types of stresses and strains, Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio and volumetric strain – Elastic moduli and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain Energy – Resilience – Gradual, sudden, impact and shock loadings – simple applications.

Module 2: Compound Stresses and Strains- Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants.

Module 3: Bending moment and Shear Force Diagrams- Bending moment (BM) and shear force (SF) diagrams.BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Module 4: *Flexural Stresses-Theory of simple bending* – Assumptions – Derivation of bending equation: M/I = f/y = E/R - Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.

Module 5: *Shear Stresses- Derivation of formula* – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections.

Module 6: Slope and deflection- Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Use of these methods to calculate slope and deflection for determinant beams.

Module 7: Torsion- Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.

Module 8: Thin Cylinders and Spheres- Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures.

Text/Reference Books:

1. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.
2. Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
3. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
4. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
5. Laboratory Manual of Testing Materials - William Kendrick Hall

6. Mechanics of Materials - Ferdinand P. Beer, E. Russel Jhonston Jr., John T. DEwolf – TMH 2002.
7. Strength of Materials by R. Subramanian, Oxford University Press, New Delhi.

Outcomes:

On completion of the course, the student will be able to:

- Describe the concepts and principles, understand the theory of elasticity including strain/displacement and Hooke's law relationships; and perform calculations, relative to the strength and stability of structures and mechanical components;
- Define the characteristics and calculate the magnitude of combined stresses in individual members and complete structures; analyze solid mechanics problems using classical methods and energy methods;
- Analyse various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress; locate the shear center of thin wall beams;and
- Calculate the deflection at any point on a beam subjected to a combination of loads; solve for stresses and deflections of beams under unsymmetrical loading; apply various failure criteria for general stress states at points; solve torsion problems in bars and thin walled members.
-

PCC-CE206	**Surveying and Geomatics**	**1L:1T**	**2 credits**

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Course Objectives

With the successful completion of the course, the student should have the capability to:

a) describe the function of surveying in civil engineering construction,
b) Work with survey observations, and perform calculations,
c) Customary units of measure. Identify the sources of measurement errors and mistakes; understand the difference between accuracy and precision as it relates to distance, differential leveling, and angular measurements,
d) Be familiar with the principals of recording accurate, orderly, complete, and logical field notes from surveying operations, whether recorded manually or with automatic data collection methods,
e) Identify and calculate the errors in measurements and to develop corrected values for differential level circuits, horizontal distances and angles for open or closed-loop traverses,
f) Operate an automatic level to perform differential and profile leveling; properly record notes; mathematically reduce and check levelling measurements,
g) Effectively communicate with team members during field activities; identify appropriate safety procedures for personal protection; properly handle and use measurement instruments. Be able to identify hazardous environments and take measures to insure one's personal and team safety,
h) Measure horizontal, vertical, and zenith angles with a transit, theodolite, total station or survey grade GNSS instruments,
i) Calculate azimuths, latitudes and departures, error of closure; adjust latitudes and departures and determine coordinates for a closed traverse,
j) Perform traverse calculations; determine latitudes, departures, and coordinates of control points and balancing errors in a traverse. Use appropriate software for calculations and

mapping,

k) Operate a total station to measure distance, angles, and to calculate differences in elevation. Reduce data for application in a geographic information system,

l) Work as a team member on a surveying party to achieve a common goal of accurate and timely project completion,

m) Calculate, design and layout horizontal and vertical curves, Understand, interpret, and prepare plan, profile, and cross-section drawings, Work with cross-sections and topographic maps to calculate areas, volumes, and earthwork quantities.

Proposed Syllabus:

Module 1: *Introduction to Surveying (8 hours):* Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Levelling: Plane table surveying, Principles of levelling- booking and reducing levels; differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling; contouring: Characteristics, methods, uses; areas and volumes.

*Triangulation and Trilateration (6 Hours)***:** Theodolite survey: Instruments, Measurement of horizontal and vertical angle; Horizontal and vertical control - methods -triangulation - network- Signals. Baseline - choices - instruments and accessories - extension of base lines - corrections - Satellite station - reduction to centre - Intervisibility of height and distances - Trigonometric leveling - Axis single corrections.

Module 2: Curves (6 hours) Elements of simple and compound curves – Method of setting out– Elements of Reverse curve - Transition curve – length of curve – Elements of transition curve - Vertical curves

Module 3: *Modern Field Survey Systems (8 Hours)*: Principle of Electronic Distance Measurement, Modulation, Types of EDM instruments, Distomat, Total Station – Parts of a Total Station – Accessories –Advantages and Applications,

Field Procedure for total station survey, Errors in Total Station Survey; Global Positioning Systems- Segments, GPS measurements, errors and biases, Surveying with GPS, Co-ordinate transformation, accuracy considerations.

Module 4: *Photogrammetry Surveying (8 Hours)*: Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping- aerial triangulation, radial triangulation, methods; photographic mapping- mapping using paper prints, mapping using stereoplotting instruments, mosaics, map substitutes.

Module 5: *Remote Sensing (9 Hours)*: Introduction –Electromagnetic Spectrum, interaction of electromagnetic radiation with the atmosphere and earth surface, remote sensing data acquisition: platforms and sensors; visual image interpretation; digital image processing.

PCC-CE206P	**Surveying Lab**, P=2hr, I Credit

Practicals:

1. Chain surveying: Chaining and chain traversing.
2. Compass traversing.

3. Leveling: Profile leveling and plotting of longitudinal section and cross sections, Y leveling. Permanent adjustment of level, reciprocal leveling, Contouring and preparation contour map.

4. Plane tabling: methods of plane table surveying, two point & three point problems

5. Setting of simple circular curves by offset method, off set from chord produced, off set from long chord and by deflection angle method

6. Theodolite: Study of theodolite, measurement of horizontal angle, measurement of vertical angle, Permanent adjustment.

7. Tachometry: Tachometric constants, calculating horizontal distance and elevations with the help of tachometer.

8. An exercise of triangulation including base line measurement.

9. Total station: Study of Total station, measurement, Permanent adjustment and exercise

Text/Reference Books:

1 Madhu, N, Sathikumar, R and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India, 2006.
2 Manoj, K. Arora and Badjatia, Geomatics Engineering, Nem Chand & Bros, 2011
3 Bhavikatti, S.S., Surveying and Levelling, Vol. I and II, I.K. International, 2010
4 Chandra, A.M., Higher Surveying, Third Edition, New Age International (P) Limited, 2002.
5 Anji Reddy, M., Remote sensing and Geographical information system, B.S. Publications, 2001.
6 Arora, K.R., Surveying, Vol-I, II and III, Standard Book House, 2015.

Outcomes:

The course will enable the students to:

- Apply the knowledge, techniques, skills, and applicable tools of the discipline to engineering and surveying activities
- Translate the knowledge gained for the implementation of Civil infrastructure facilities
- Relate the knowledge on Surveying to the new frontiers of science like Hydrographic surveying, Electronic Distance Measurement, Global Positioning System, Photogrammetry and Remote Sensing.

PCC-CE207	Materials, Testing & Evaluation	1L:1T	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to deal with an experimental determination and evaluation of mechanical characteristics and advanced behavior of metallic and non-metallic structural materials. The course deals with explanation of deformation and fracture behavior of structural materials. The main goal of this course is to provide students with all information concerning principle, way of measurement, as well as practical application of mechanical characteristics.

- Make measurements of behavior of various materials used in Civil Engineering.
- Provide physical observations to complement concepts learnt
- Introduce experimental procedures and common measurement instruments, equipment, devices.
- Exposure to a variety of established material testing procedures and techniques
- Different methods of evaluation and inferences drawn from observations

The course reviews also the current testing technology and examines force applications systems, force measurement, strain measurement, important instrument considerations, equipment for environmental testing, and computers applications for materials testing provide an introductory treatment of *basic skills in material engineering towards (i) selecting material for the design, and (ii) evaluating the mechanical and structural properties of material, as well as the knowledge necessary for a civil engineer.* The knowledge acquired lays a good foundation for analysis and design of various civil engineering structures/systems in a reliable manner.

What will I learn?

- Different materials used in civil engineering applications
- Planning an experimental program, selecting the test configuration, selecting the test specimens and collecting raw data
- Documenting the experimental program including the test procedures, collected data, method of interpretation and final results
- Operating the laboratory equipment including the electronic instrumentation, the test apparatus and the data collection system
- Measuring physical properties of common structural and geotechnical construction materials
- Interpreting the laboratory data including conversion of the measurements into engineering values and derivation of material properties (strength and stiffness) from the engineering values
- Observing various modes of failure in compression, tension, and shear
- Observing various types of material behavior under similar loading conditions

Proposed Syllabus

Module 1: *Introduction to Engineering Materials covering,* Cements, M-Sand, Concrete (plain, reinforced and steel fibre/ glass fibre-reinforced, light-weight concrete, High Performance Concrete, Polymer Concrete) Ceramics, and Refractories, Bitumen and asphaltic materials, Timbers, Glass and Plastics, Structural Steel and other Metals, Paints and Varnishes, Acoustical material and geo-textiles, rubber and asbestos, laminates and adhesives, Graphene, Carbon composites and other engineering materials including properties and uses of these

Module 2: *Introduction to Material Testing covering,* What is the " Material Engineering" ?; Mechanical behavior and mechanical characteristics; Elasticity – principle and characteristics; Plastic deformation of metals; Tensile test – standards for different material (brittle, quasi-brittle, elastic and so on) True stress – strain interpretation of tensile test; hardness tests; Bending and torsion test; strength of ceramic; Internal friction, creep – fundaments and characteristics; Brittle fracture of steel – temperature transition approach; Background of fracture mechanics; Discussion of fracture toughness testing – different materials; concept of fatigue of materials; Structural integrity assessment procedure and

fracture mechanics

Module 3: *Standard Testing & Evaluation Procedures covering*, Laboratory for mechanical testing; Discussion about mechanical testing; Naming systems for various irons, steels and

nonferrous metals; Discussion about elastic deformation; Plastic deformation; Impact test and transition temperatures; Fracture mechanics – background; Fracture toughness – different materials; Fatigue of material; Creep.

Tutorials *from the above modules covering*, understanding i) Tests & testing of bricks, ii) Tests & testing of sand, iii) Tests & testing of concrete, iv) Tests & testing of soils, v) Tests & testing of bitumen & bituminous mixes, vi) Tests & testing of polymers and polymer based materials, vii) Tests & testing of metals & viii) Tests & testing of other special materials, composites and cementitious materials. Explanation of mechanical behavior of these materials.

Text/Reference Books:

1. Chudley, R., Greeno (2006), 'Building Construction Handbook' (6th ed.),R. Butterworth-Heinemann
2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand& Bros, Fifth Edition
3. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materialsused for Civil Engineering applications
4. Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella
5. E.N. Dowling (1993), Mechanical Behaviour of Materials,Prentice Hall International Edition
6. American Society for Testing and Materials (ASTM), *Annual Book of ASTM Standards* (post 2000)

Measurable Outcomes:

One should be able to:

- Calibrate electronic sensors
- Operate a data acquisition system
- Operate various types of testing machines
- Configure a testing machine to measure tension or compression behavior
- Compute engineering values (e.g. stress or strain) from laboratory measures
- Analyze a stress versus strain curve for modulus, yield strength and other related attributes
- Identify modes of failure
- Write a technical laboratory report

PCC-CE207P	Materials Testing Lab

Practicals(2 hr/week-1 credit):

- Gradation of coarse and fine aggregates
- Different corresponding tests and need/application of these tests in design and quality control
- Tensile Strength of materials & concrete composites
- Compressive strength test on aggregates
- Tension I - Elastic Behaviour of metals & materials

- Tension II - Failure of Common Materials
- Direct Shear - Frictional Behaviour
- Concrete I - Early Age Properties
- Concrete II - Compression and Indirect Tension
- Compression – Directionality
- Soil Classification
- Consolidation and Strength Tests
- Tension III - Heat Treatment
- Torsion test
- Hardness tests (Brinnel's and Rockwell)
- Tests on closely coiled and open coiled springs
- Theories of Failure and Corroboration with Experiments
- Tests on unmodified bitumen and modified binders with polymers
- Bituminous Mix Design and Tests on bituminous mixes - Marshall method
- Concrete Mix Design as per BIS

ESC209	Mechanical Engineering	2L:1T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1:Basic Concepts- Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasistatic process, work, modes of work. Zeroth law of thermodynamics, concept of temperature and heat. Concept of ideal and real gases.

Module 2: First Law of Thermodynamics- Concepts of Internal Energy, Specific Heat Capacities, Enthalpy. Energy Balance for Closed and Open Systems, Energy Balance for Steady-Flow Systems. Steady-Flow Engineering Devices. Energy Balance for Unsteady-Flow

Module 3: Second Law of Thermodynamics- Thermal energy reservoirs, heat engines energy conversion, Kelvin's and Clausius statements of second law, the Carnot cycle, the Carnot Theorem, the thermodynamic temperature scale, the Carnot heat engine, efficiency, the Carnot refrigerator and heat pump, COP. Clausius inequality, concept of entropy, principle of increase of entropy – availability, the increase of entropy principle, perpetual-motion machines, reversible and irreversible processes, Entropy change of pure substances, isentropic processes, property diagrams involving entropy, entropy change of liquids and solids, the entropy change of ideal gases, reversible steady-flow work, minimizing the compressor work, isentropic efficiencies of steady-flow devices, and entropy balance. Energy - a measure of work potential, including work potential of energy, reversible work and irreversibility, second-law efficiency, exergy change of a system, energy transfer by heat, work, and mass, the decrease of exergy principle and exergy destruction, energy balance: closed systems and control volumes energy balance.

Module 4: Properties Of Pure Substance- Properties of pure substances. Thermodynamic properties of pure substances in solid, liquid and vapour phases. Phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces. Thermodynamic properties of steam. Calculations of work done and heat transfer in non- flow and flow processes.

Module 5: Power Cycles- Vapour and combined power cycles, including the Carnot vapor cycle, Rankine cycle: the ideal cycle for vapor power, the ideal reheat and regenerative and the second-law analysis of vapour power cycles. Gas power cycles, including basic considerations in the analysis of power cycles, the Carnot cycle and its value in engineering, an overview of reciprocating engines, air standard assumptions,gasoline engine Otto cycle, diesel engine cycle, gas-turbine Brayton cycle, and the second-law analysis of gas power cycles.

Module 6: Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling. Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables. Refrigeration cycles, including refrigerators and heat pumps, the ideal reversed Carnot vapour-compression refrigeration cycle, actual vapor-compression refrigeration cycles, heat pump systems, gas refrigeration cycles, and absorption refrigeration systems.

Text/Reference Books:

1. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi.
2. Cengel, Thermodynamics – An Engineering Approach *Tata McGraw Hill, New* Delhi.
3. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley.
4. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering

1. Thermodynamics: John Wiley & Sons.

5. Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall.
6. Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.

Upon successful completion of the course, student will have:

- Ability to apply mathematics, science, and engineering
- Ability to design and conduct experiments, as well as to analyze and interpret data
- Ability to identify, formulate, and solve engineering problems
- Ability to apply modern engineering tools, techniques and resources to solve complex mechanical engineering activities with an understanding of the limitations.
- Ability to comprehend the thermodynamics and their corresponding processes that influence the behaviour and response of structural components

  Ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) and thermodynamics to model, analyze, design, and realize physical systems, components, or processes.

5th Semester

PCC-CE301	Mechanics of Materials	2L:1T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The objective of this Course is to introduce to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum

balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design. The overarching theme is a unified mechanistic language using thermodynamics, which allows understanding, modelling and design of a large range of engineering materials. The subject of mechanics of materials involves analytical methods for determining the strength, stiffness (deformation characteristics), and stability of the various members in a structural system. The behavior of a member depends not only on the fundamental laws that govern the equilibrium of forces, but also on the mechanical characteristics of the material. These mechanical characteristics come from the laboratory, where materials are tested under accurately known forces and their behavior is carefully observed and measured (learnt in the previous course on Materials, Testing & Evaluation). For this reason, mechanics of materials is a blended science of experiment and Newtonian postulates of analytical mechanics.

What will I learn?

- Understand the deformation and strains under different load action and response in terms of forces and moments
- Understand the behaviour under different loading actions
- Application of engineering principles to calculate the reactions, forces and moments
- Understand the energy methods used to derive the equations to solve engineering problems
- Make use of the capabilities to determine the forces and moments for design

Proposed Syllabus

Module 1: *Deformation and Strain covering* description of finite deformation, Infinitesimal deformation; Analysis of statically determinate trusses; Stability of dams, retaining walls and chimneys; Stress analysis of thin, thick and compound cylinder;

Module 2:*Generalized state of stress and strain:* Stress and strain tensor, Yield criteria and theories of failure; Tresca, Von-Mises, Hill criteria, Heigh-Westerguard's stress space.

Module 3:*Momentum Balance and Stresses covering* Forces and Moments Transmitted by Slender Members, Shear Force and Bending Moment Diagrams, Momentum Balance, Stress States / Failure Criterion

Module 4:*Mechanics of Deformable Bodies covering* Force-deformation Relationships and Static Indeterminacy, Uniaxial Loading and Material Properties, Trusses and Their Deformations, Statically Determinate and Indeterminate Trusses,

Module 5:*Force-Stress-Equilibrium covering* Multiaxial Stress and Strain

Module 6: *Displacement – Strain covering* Multiaxial Strain and Multiaxial Stress-strain Relationships

Module 7: *Elasticity and Elasticity Bounds covering*Stress-strain-temperature Relationships and Thin-walled Pressure Vessels,Stress and strain Transformations and Principal Stress, Failure of Materials,

Module 8:*Bending: Stress and Strains; Deflections and Torsion covering* Pure Bending, Moment-curvature Relationship, Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams, Shear and Torsion, Torsion and Twisting, Thermoelasticity, Energy methods, Variational Methods; Strain energy, elastic, complementary and total strain energy,

Strain energy of axially loaded bar, Beam in bending, shear and torsion; General energy theorems, Castigliano's theorem, Maxwell Bettie's reciprocal theorem; Virtual work and unit load method for deflection, Application to problems of beams and frames.

Module 9:*Structural stability;* Stability of columns, Euler's formula, end conditions and effective length factor, Columns with eccentric and lateral load; Plasticity and Yield Design covering 1D-Plasticity – An Energy Approach, Plasticity Models, Limit Analysis and Yield Design

Text/Reference Books:

1. Norris, C.H. and Wilber, J. B. and Utku, S. "Elementary Structural Analysis" Mc Graw Hill, Tokyo, Japan.
2. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.
3. Kazmi, S. M. A., 'Solid Mechanics" TMH, Delhi, India.
4. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
5. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
6. Gere, J. M., and S. P. Timoshenko. *Mechanics of Materials.* 5th ed. Boston: PWS Kent Publishing, 1970.
7. Ashby, M. F., and D. R. H. Jones. *Engineering Materials, An Introduction to their Properties and Applications.* 2nd ed. Butterworth Heinemann.
8. Collins, J. A. *Failure of Materials in Mechanical Design.* 2nd ed. John Wiley & Sons, 1993.
9. Courtney, T. H. *Mechanical Behavior of Materials.* McGraw-Hill, 1990.
10. Hertzberg, R. W. *Deformation and Fracture Mechanics of Engineering Materials.* 4th ed. John Wiley & Sons, 1996.
11. Nash, W. A. *Strength of Materials.* 3d ed. Schaum's Outline Series, McGraw-Hill, 1994.

Outcomes:

At the end of the course, the student will have

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design a system, component, or process to meet desired needs
- an ability to identify, formulate, and solve engineering problems
- the broad education necessary to understand the impact of engineering solutions in a global and societal context
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- an ability to apply principles of engineering, basic science, and math to model, analyze, design and realize physical systems, components or processes

PCC-CE302	Hydraulic Engineering	3L:0T	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Objectives:

To introduce the students to various hydraulic engineering problems like open channel flows

and hydraulic machines. At the completion of the course, the student should be able to relate the theory and practice of problems in hydraulic engineering

Module 1: Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity.

Module 2: Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram.

Module 3:Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.

Module 4: Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem.

Module 5: Introduction to Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

Module 6: Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient " n .*Most economical section of ch*annel. Computation of Uniform flow, Normal depth.

Module 7 : Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.

Module 8: Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types,applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation,

Module 9: Flow through Pipes: Loss of head through pipes, Darcy-Wiesbatch equation,

minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem.

Module 10: Computational Fluid Dynamics: Basic equations of fluid dynamics, Grid generation, Introduction to in viscid incompressible flow, Boundary layer flow as applicable to C.F.D. Hydro informatics: Concept of hydro informatics –scope of internet and web based modeling in water resources engineering.

Text/Reference Books:

1. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
2. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill.
3. Open channel Flow, K. Subramanya, Tata McGraw Hill.
4. Open Channel Hydraulics, Ven Te Chow, Tata McGraw Hill.
5. Burnside, C.D., "*Electromagnetic Distance Measurement*," Beekman Publishers, 1971.

Outcomes:

- The students will be able to apply their knowledge of fluid mechanics in addressing problems in open channels.
- They will possess the skills to solve problems in uniform, gradually and rapidly varied flows in steady state conditions.
- They will have knowledge in hydraulic machineries (pumps and turbines).

PCC-CE302 P	**Hydraulic Engineering**

Practical Work(2hr/week):

1. Flow Visualization
2. Studies in Wind Tunnel
3. Boundary Layer
4. Flow around an Aerofoil / circular cylinder
5. Uniform Flow
6. Velocity Distribution in Open channel flow
7. Venturi Flume
8. Standing Wave Flume
9. Gradually Varied Flow
10. Hydraulic Jump
11. Flow under Sluice Gate
12. Flow through pipes
13. Turbulent flow through pipes
14. Flow visualization
15. Laminar flow through pipes

16. Major losses / Minor losses in pipe

PCC-CE303	Structural Engineering	2L:1T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Objectives:
This course aims at providing students with a solid background on principles of structural engineering design. Students will be exposed to the theories and concepts of both concrete and steel design and analysis both at the element and system levels. Hands-on design experience and skills will be gained and learned through problem sets and a comprehensive design project. An understanding of real-world open-ended design issues will be developed. Weekly recitations and project discussions will be held besides lectures.

Module 1: Introduction- concepts of energy principles, safety, sustainable development in performance; what makes a structure; principles of stability, equilibrium; what is a structural engineer, role of engineer, architect, user, builder; what are the functions' what do the engineers design, first principles of process of design

Module 2: Planning and Design Process; Materials, Loads, and Design Safety; Behaviour and Properties of Concrete and Steel; Wind and Earthquake Loads

Module 3: *Materials and Structural Design Criteria:* Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and design philosophies for structural engineering. Laboratory experiments dealing with the analysis of determinate and indeterminate structures;

Module 4:*Design of Structural Elements;* Concrete Elements, Steel Elements, Structural Joints; Theories and concepts of both concrete and steel design and analysis both at the element and system levels. Approximate Analysis Methods as a Basis for Design; Design of Reinforced Concrete Beams for Flexure; Design of Reinforced Concrete Beams for Shear; Bond, Anchorage, and Serviceability; Reinforced Concrete Columns; Reinforced Concrete Slabs; Introduction to Steel Design; Tension Members and Connections; Bending Members; Structural Systems

Module 5: *System Design Concepts;* Special Topics that may be Covered as Part of the Design Project Discussions; Cable Structures; Prestressed Concrete Bridges; Constructability and Structural Control; Fire Protection

Text/Reference Books:

1. Nilson, A. H. *Design of Concrete Structures.* 13th edition. McGraw Hill, 2004
2. McCormac, J.C., Nelson, J.K. Jr., *Structural Steel Design*. 3rd edition. Prentice Hall, N.J., 2003.
3. Galambos, T.V., Lin, F.J., Johnston, B.G., *Basic Steel Design with LRFD*, Prentice Hall, 1996
4. Segui, W. T., *LRFD Steel Design,* 2nd Ed., PWS Publishing, Boston.
5. Salmon, C.G. and Johnson, J.E., *Steel Structures: Design and Behavior*, 3rd Edition, Harper & Row, Publishers, New York, 1990.
6. MacGregor, J. G., *Reinforced Concrete: Mechanics and Design*, 3rd Edition, Prentice Hall, New Jersey, 1997.

7. Nawy, E. G., *Reinforced Concrete: A Fundamental Approach*, 5th Edition, Prentice Hall, New Jersey.
8. Wang C-K. and Salmon, C. G., *Reinforced Concrete Design*, 6th Edition, Addison Wesley, New York.
9. Nawy, E. G. *Prestressed Concrete: A Fundamental Approach*, Prentice Hall, NJ, (2003).
10. Related Codes of Practice of BIS
11. Smith, J. C., *Structural Analysis*, Harpor and Row, Publishers, New York.
12. W. McGuire, R. H. Gallagher and R. D. Ziemian. "Matrix Structural Analysis", 2nd Edition, John Wiley and Sons, 2000.
13. NBC, *National Building Code*, BIS (2017).
14. ASCE, *Minimum Design Loads for Buildings and Other Structures, ASCE 7-02*, American Society of Civil Engineers, Virginia, 2002.

Outcomes:

- The students will be able to apply their knowledge of structural mechanics in addressing design problems of structural engineering
- They will possess the skills to solve problems dealing with different loads and concrete and steel
- They will have knowledge in structural engineering

PCC-CE304	Geotechnical Engineering	3L:0T	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: *Introduction*–Types of soils, their formation and deposition, Definitions: soil mechanics, soil engineering, rock mechanics, geotechnical engineering. Scope of soil engineering. Comparison and difference between soil and rock. Basic Definitions and Relationships-Soil as three-phase system in terms of weight, volume, voids ratio, and porosity. Definitions: moisture content, unit weights, degree of saturation, voids ratio, porosity, specific gravity, mass specific gravity, etc. Relationship between volume weight, voids ratio- moisture content, unit weight- percent air voids, saturation- moisture content, moisture content- specific gravity etc. Determination of various parameters such as: Moisture content by oven dry method, pycnometer, sand bath method, torsional balance method,nuclear method, alcohol method and sensors. Specific gravity by density bottle method, pycnometer method, measuring flask method. Unit weight by water displacement method, submerged weight method, core-cutter method, sand-replacement method.

Module 2: *Plasticity Characteristics of Soil* - Introduction to definitions of: plasticity of soil, consistency limits-liquid limit, plastic limit, shrinkage limit, plasticity, liquidity and consistency indices, flow & toughness indices, definitions of activity and sensitivity. Determination of: liquid limit, plastic limit and shrinkage limit. Use of consistency limits. Classification of Soils-Introduction of soil classification: particle size classification, textural classification, unified soil classification system, Indian standard soil classification system. Identification: field identification of soils, general characteristics of soil in different groups.
On completion of this module, the students must be able to:

- Understand the behaviour of soils based on their moisture contents;
- Perform laboratory experiments to estimate various Atterberg limits and evaluate index properties of soils;
- Classify any soils based on their particle size distribution and index properties;

Module 3: *Permeability of Soil* - Darcy's law, validity of Darcy's law. Determination of coefficient of permeability: Laboratory method: constant-head method, falling-head method. Field method: pumping- in test, pumping- out test. Permeability aspects: permeability of stratified soils, factors affecting permeability of soil. Seepage Analysis- Introduction, stream and potential functions, characteristics of flow nets, graphical method to plot flow nets.
On completion of this module, the student must be able to:

- Determine the permeability of soils through various laboratory and field tests;
- Analytically calculate the effective permeability of anisotropic soil mass;
- Determine the seepage quantities and pore water pressures below the ground;
- Graphically plot the equipotential lines and flow lines in a seepage flow.

Module 4:*Effective Stress Principle* - Introduction, effective stress principle, nature of effective stress, effect of water table. Fluctuations of effective stress, effective stress in soils saturated by capillary action, seepage pressure, quick sand condition.
On completion of this module, the student must be able to:

- Understand the physical significance of effective stress and its relation with pore pressure;
- Plot various stress distribution diagrams along the depth of the soil mass;
- Understand the effect of capillary action and seepage flow direction on the effective stress at a point in the soil mass.

Module 5: *Compaction of Soil*-Introduction, theory of compaction, laboratory determination of optimum moisture content and maximum dry density. Compaction in field, compaction specifications and field control.
On completion of this module, the student must be able to:

- Perform laboratory test to determine the maximum dry density and optimum moisture content of the soil;
- Variation in compaction curve with compaction effort and soil type;
- Determine the compactive effort required to obtain necessary degree of compaction in-situ;
- Differentiate among various field methods of compaction and their usage based on the type of soil.

Module 6:*Stresses in soils* – Introduction, stresses due to point load, line load, strip load, uniformly loaded circular area, rectangular loaded area. Influence factors, Isobars, Boussinesq's equation, Newmark's Influence Chart. Contact pressure under rigid and flexible area, computation of displacements from elastic theory.
On completion of this module, the student must be able to:

- Analytically compute the vertical stress in a semi-infinite soil mass due to various loading conditions;
- Plot isobars due various loading conditions.

Module 7:*Consolidation of Soil* - Introduction, comparison between compaction and consolidation, initial, primary & secondary consolidation, spring analogy for primary consolidation, interpretation of consolidation test results, Terzaghi's theory of consolidation, final settlement of soil deposits, computation of consolidation settlement and secondary

consolidation.
On completion of this module, the student must be able to:

- Understand the basic mechanism of consolidation of soil;
- Determine various consolidation parameters of soil through laboratory test;
- Evaluate ground settlements against time.

Module 8:*Shear Strength* - Mohr circle and its characteristics, principal planes, relation between major and minor principal stresses,Mohr-Coulomb theory, types of shear tests: direct shear test, merits of direct shear test, triaxial compression tests, test behaviour of UU, CU and CD tests, pore-pressure measurement, computation of effective shear strength parameters.unconfined compression test, vane shear test
On completion of this module, the student must be able to:

- Determine graphically and analytically the stress state in any plane of the soil mass;
- Perform various shear strength tests and appreciate the different field conditions which they simulate;
- Understand the significance of shear strength parameters in various geotechnical analyses;
- Evaluate the stiffness of soil using shear strength parameters

Module 9:*Stability of Slopes* - Introduction, types of slopes and their failure mechanisms, factor of safety, analysis of finite and infinite slopes, wedge failure Swedish circle method, friction circle method, stability numbers and charts.
On completion of this module, the student must be able to:

- Differentiate various modes of slope failure;
- Evaluate factor of safety of infinite slopes based on different ground conditions;
- Understand various methods for computation of factor of safety for finite slopes.

Module 10:*Soil Exploration*- Introduction, methods of site exploration and soil investigation, methods of boring, soil samplers, sampling procedures, trail pits, borings, penetrometer tests, analysis of borehole logs, geophysical and advance soil exploration methods.

On completion of this module, the student must be able to:

- Specify a strategy for site investigation to identify the soil deposits and determine the depth and spatial extent within the ground;
- Understand various site investigation techniques and their in-situ applications;
- Prepare a soil investigation report based on borehole log data and various in-situ tests like SPT, CPT, etc.

Text/Reference Books:

1. Soil Mechanics by Craig R.F., Chapman & Hall
2. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
3. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., Prentice Hall, NJ
4. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
5. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning

PCC-CE304P	**Geotechnical Engineering Lab**

P=2hr/week, I Credit

Practical Work: List of tests on-

1. Field Density using Core Cutter method.
2. Field Density using Sand replacement method.
3. Natural moisture content using Oven Drying method.
4. Field identification of Fine Grained soils.
5. Specific gravity of Soils.
6. Grain size distribution by Sieve Analysis.
7. Grain size distribution by Hydrometer Analysis.
8. Consistency limits by Liquid limit
9. Consistency limits by Plastic limit
10. Consistency limits by Shrinkage limit.
11. Permeability test using Constant-head test method.
12. Permeability test using Falling-head method.
13. Compaction test: Standard Proctor test.
14. Compaction test: Modified Proctor test.
15. Relative density.
16. Consolidation Test.
17. Triaxial Test (UU)
18. Vane shear test
19. Direct Shear Test
20. Unconfined Compression Strength Test.

PCC-CE305	Hydrology and Water Resources Engineering	2L:1T:0P	3 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: *Introduction* - hydrologic cycle, water-budget equation, history of hydrology, world
water balance, applications in engineering, sources of data.

Module 2: *Precipitation* - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth-area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.

Module 3:*Abstractions from precipitation* - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices.

Module 4:*Runoff* - runoff volume, SCS-CN method of estimating runoff volume, flow-duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows.

Module 5: *Ground water and well hydrology* - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.

Module 6:*Water withdrawals and uses* – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation.

Module 7:*Distribution systems* - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals, types of lining. Drainage of irrigated lands: necessity, methods.

Module 8: *Dams and spillways* - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.

Text/Reference Books:

1. K Subramanya, Engineering Hydrology, Mc-Graw Hill.
2. K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill.
3. K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill.
4. G L Asawa, Irrigation Engineering, Wiley Eastern
5. L W Mays, Water Resources Engineering, Wiley.
6. J D Zimmerman, Irrigation, John Wiley & Sons
7. C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.

Outcomes:

At the end of the course, students must be in a position to:

- Understand the interaction among various processes in the hydrologic cycle
- Apply the application of fluid mechanics and use of computers in solving a host of problems in hydraulic engineering
- Study types and classes of hydrologic simulation models and design procedures for safe and effective passage of flood flows for design of hydraulic structures
- Understand the basic aquifer parameters and estimate groundwater resources for different hydro-geological boundary conditions
- Understand application of systems concept, advanced optimization techniques to cover the socio-technical aspects in the field of water resources
- Apply the principles and applications of remote sensing, GPS and GIS in the context to hydrological extreme flood and drought events in water resources engineering

PCC-CE306	Environmental Engineering	2L:0T	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: *Water:* -Sources of Water and quality issues, water quality requirement for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, Need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.
Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes

Module 2: *Sewage*- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans,

Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.

Module 3: *Air* - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

Module 4: *Noise*- Basic concept, measurement and various control methods.

Module5:*Solid waste management*-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods-Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

Module 6: *Building Plumbing*-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

Module 7: Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.

Text/Reference Books:

1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey.
2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008.
3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. *Environmental Engineering*, Mc-Graw - Hill International Editions, New York 1985.
4. MetCalf and Eddy. *Wastewater Engineering, Treatment, Disposal and Reuse*, Tata McGraw-Hill, New Delhi.
5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.
6. Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999
7. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication
8. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.

PCC-CE306P	Environmental Engineering Lab

P=2hr/week, I Credit

List of Experiments:

1) Flow measurements in closed conduits – venturimeter, orifices.

2) Determination of Color & Turbidity.
3) Determination of Solids: Total, Dissolved and Suspended; dissolved solids through conductivity.
4) Determination of Alkalinity and its species.
5) Determination of pH, and Acidity and its species.
6) Determination of Hardness (different types)
7) Determination of Chlorides.
8) Determination of Fluorides.
9) Jar test for optimum coagulant dose estimation.
10) Determination of residual chlorine and chlorine dose.

Outcomes:
After successfully studying this course, students will:
- Understand the impact of humans on environment and environment on humans
- Be able to identify and value the effect of the pollutants on the environment: atmosphere, water and soil.
- Be able to plan strategies to control, reduce and monitor pollution.
- Be able to select the most appropriate technique for the treatment of water, wastewater solid waste and contaminated air.
- Be conversant with basic environmental legislation.

PCC-CE307	Transportation Engineering	2L:0T	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.

Module 2: Geometric design of highways-: Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

Module 3:Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; design of road intersections; design of parking facilities; highway lighting; problems

Module 4:Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems

Module 5: Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements- components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems.

Text/Reference Books:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers.
3. Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning,

4. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,'Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley
5. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011.
6. Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.

On completion of the course, the students will be able to:

- carry out surveys involved in planning and highway alignment
- design the geometric elements of highways and expressways
- carry out traffic studies and implement traffic regulation and control measures and intersection design
- characterize pavement materials and
- design flexible and rigid pavements as per IRC

PCC-CE307P	**Transportation Engineering Lab**

P=2hr/week, I Credit

Practicals:

1) Flakiness and elongation test
2) Marshal Stability test
3) C B R Value test
4) Bulk density and Void test
5) Dorry Abrasion Test
6) Specific gravity test
7) Solubility Test
8) Aggregates Hardness,Toughness, Cementation, Adhesiveness tests
9) Shearing test on soil
10) Aggregate's Water absorption Test
11) Aggregate Impact Test
12) Los-Angeles Abrasion Test on Aggregates
13) Dorry's Abrasion Test on Aggregates
14) Deval Attrition Test on Aggregates
15) Crushing Strength Test on Aggregates
16) Penetration Test on Bitumen.
17) Ductility Test on Bitumen
18) Viscosity Test on Bituminous Material
19) Softening Point Test on Bitumen.
20) Flash and Fire Point Test on Bitumen

6th Semester

PCC-CE308	**Construction Engineering & Management**	**2L:1T:0P**	**3 credits**

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1: *Basics of* Construction- Unique features of construction, construction projects-types and features, phases of a project, agencies involved and their methods of execution;

Module 2: Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks.PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.

Module 3: Construction Methods basics: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Module 4: Construction Equipment basics*:* Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities.

Module 5: Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling. Common Good Practices in Construction

Module 6:*Project Monitoring & Control*- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Module 7:*Contracts Management basics:* Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.

Module 8:*Construction Costs: Make-up of construction costs;* Classification of costs, time-cost trade-off in construction projects, compression and decompression.

Text/Reference Books:

1. Varghese, P.C., "*Building Construction"*, Prentice Hall India, 2007.
2. *National Building Code,* Bureau of Indian Standards, New Delhi, 2017.
3. Chudley, R., *Construction Technology*, ELBS Publishers, 2007.
4. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011
5. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006
6. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015
7. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016.

On completion of the course, the students will have:

- An idea of how structures are built and projects are developed on the field
- An understanding of modern construction practices
- A good idea of basic construction dynamics- various stakeholders, project objectives, processes, resources required and project economics.

- A basic ability to plan, control and monitor construction projects with respect to time and cost
- An idea of how to optimise construction projects based on costs
- An idea how construction projects are administered with respect to contract structures and issues.
- An ability to put forward ideas and understandings to others with effective communication processes

PCC-CE309	**Engineering Economics, Estimation & Costing**	**2L:1T**	**3 credits**

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

Module 1:Basic Principles and Methodology of Economics. Demand/Supply – elasticity – Government Policies and Application. Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes (3 lectures)

Module 2: Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve. (2 lectures)

Module 3: Elements of Business/Managerial Economics and forms of organizations. Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method. (3 lectures)

Module 4: Indian economy - Brief overview of post-independence period – plans. Post

reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors. (2 lectures)

Module 5:*Estimation* / Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying (7 lectures).

Module 6: Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures. (3 lectures)

Module 7: Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity. (3 lectures)

Module 8: Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management (6 lectures)

Module 9: Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights. (1 lecture).

On completion of the course, the students will:

- Have an idea of Economics in general, Economics of India particularly for public sector agencies and private sector businesses
- Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
- Be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.
- Be able to understand the technical specifications for various works to be performed for a project and how they impact the cost of a structure.
- Be able to quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure.
- Be able to understand how competitive bidding works and how to submit a competitive bid proposal.

Text/Reference Books:

1. Mankiw Gregory N. (2002), *Principles of Economics,* Thompson Asia
2. V. Mote, S. Paul, G. Gupta(2004), *Managerial Economics,* Tata McGraw Hill
3. Misra, S.K. and Puri (2009), *Indian Economy,* Himalaya
4. Pareek Saroj (2003), *Textbook of Business Economics,* Sunrise Publishers
5. M Chakravarty, Estimating, Costing Specifications & Valuation

6. Joy P K, Handbook of Construction Management, Macmillan
7. B.S. Patil, Building & Engineering Contracts
8. Relevant Indian Standard Specifications.
9. World Bank Approved Contract Documents.
10. FIDIC Contract Conditions.
11. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration
12. Typical PWD Rate Analysis documents.
13. UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations,2016
14. Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016

PCC-CE309P	**Engineering Economics, Estimation & Costing Lab**

P=2hr/week, I Credit

1. Deriving an approximate estimate for a multistoried building by approximate methods.
2. Detailed estimate for the following with the required material survey for the same.
    a. Ground plus three storied RCC Framed structure building with blockwork walls
    b. bridge with minimum 2 spans
    c. factory building
    d. road work
    e. cross drainage work
    f. Ground plus three storied building with load-bearing walls
    g Cost of finishes, MEP works for (f) above
3. Preparation of valuation report in standard Government form.
4. Assignments on rate analysis, specifications and simple estimates.
5. Detailed estimate of minor structure.
6. Preparation of Bar bending schedule.

B.Tech 7th Semester

HSMC252	Civil Engineering – Societal & Global Impact	2L:0T:0P	2 credits

Theory= 75 , Sessionals=25 , Total=100 Duration of exam.=3 hours

The course is designed to provide a better understanding of the impact which Civil Engineering has on the Society at large and on the global arena. Civil Engineering projects have an impact on the Infrastructure, Energy consumption and generation, Sustainability of the Environment, Aesthetics of the environment, Employment creation, Contribution to the GDP, and on a more perceptible level, the Quality of Life. It is important for the civil engineers to realise the impact which this field has and take appropriate precautions to ensure that the impact is not adverse but beneficial.

The course covers:

- Awareness of the importance of Civil Engineering and the impact it has on the Society and at global levels
- Awareness of the impact of Civil Engineering for the various specific fields of human endeavour
- Need to think innovatively to ensure Sustainability

Module 1: Introduction to Course and Overview; Understanding the past to look into the future: Pre-industrial revolution days, Agricultural revolution, first and second industrial revolutions, IT revolution; Recent major Civil Engineering breakthroughs and innovations; Present day world and future projections, Ecosystems in Society and in Nature; the steady erosion in Sustainability; Global warming, its impact and possible causes; Evaluating future requirements for various resources; GIS and applications for monitoring systems; Human Development Index and Ecological Footprint of India Vs other countries and analysis;

Module 2: Understanding the importance of Civil Engineering in shaping and impacting the world; The ancient and modern Marvels and Wonders in the field of Civil Engineering; Future Vision for Civil Engineering

Module 3: Infrastructure - Habitats, Megacities, Smart Cities, futuristic visions; Transportation (Roads, Railways & Metros, Airports, Seaports, River ways, Sea canals, Tunnels (below ground, under water); Futuristic systems (ex, Hyper Loop)); Energy generation (Hydro, Solar (Photovoltaic, Solar Chimney), Wind, Wave, Tidal, Geothermal, Thermal energy); Water provisioning; Telecommunication needs (towers, above-ground and underground cabling); Awareness of various Codes & Standards governing Infrastructure development; Innovations and methodologies for ensuring Sustainability;

Module 4: Environment- Traditional & futuristic methods; Solid waste management, Water purification, Wastewater treatment & Recycling, Hazardous waste treatment; Flood control (Dams, Canals, River interlinking), Multi-purpose water projects, Atmospheric pollution; Global warming phenomena and Pollution Mitigation measures, Stationarity and non-stationarity; Environmental Metrics & Monitoring; Other Sustainability measures; Innovations and methodologies for ensuring Sustainability.

Module 5: Built environment – Facilities management, Climate control; Energy efficient built environments and LEED ratings, Recycling, Temperature/ Sound control in built environment, Security systems; Intelligent/ Smart Buildings; Aesthetics of built environment, Role of Urban Arts Commissions; Conservation, Repairs & Rehabilitation of Structures & Heritage structures; Innovations and methodologies for ensuring Sustainability

Module 6: Civil Engineering Projects – Environmental Impact Analysis procedures; Waste (materials, manpower, equipment) avoidance/ Efficiency increase; Advanced construction techniques for better sustainability; Techniques for reduction of Green House Gas emissions in various aspects of Civil Engineering Projects; New Project Management paradigms & Systems (Ex. Lean Construction), contribution of Civil Engineering to GDP, Contribution to employment(projects, facilities management), Quality of products, Health & Safety aspects for stakeholders; Innovations and methodologies for ensuring Sustainability during Project development;

ORGANISATION OF COURSE (2-0-0)

S. No.	Module	No of Lectures	Details
1	Introduction	3	
2	Understanding the Importance of Civil Engineering	3	
3	Infrastructure	8	
4	Environment	7	
5	Built Environment	5	
6	Civil Engineering Projects	4	
	TOTAL	**30**	

Text/Reference Books:

1. *Žiga* Turk (2014), Global Challenges and the Role of Civil Engineering, Chapter 3 in: Fischinger M. (eds) Performance-Based Seismic Engineering: Vision for an Earthquake Resilient Society. Geotechnical, Geological and Earthquake Engineering, Vol. 32. Springer, Dordrecht
2. Brito, Ciampi, Vasconcelos, Amarol, Barros (2013) Engineering impacting Social, Economical and Working Environment, 120th ASEE Annual Conference and Exposition
3. NAE Grand Challenges for Engineering (2006), Engineering for the Developing World, The Bridge, Vol 34, No.2, Summer 2004.
4. Allen M. (2008) Cleansing the city. Ohio University Press. Athens Ohio.
5. Ashley R., Stovin V., Moore S., Hurley L., Lewis L., Saul A. (2010). London Tideway Tunnels Programme – Thames Tunnel Project Needs Report – Potential

source control and SUDS applications: Land use and retrofit options
6. http://www.thamestunnelconsultation.co.uk/consultation-documents.aspx
7. Ashley R M., Nowell R., Gersonius B., Walker L. (2011). Surface Water Management and Urban Green Infrastructure. Review of Current Knowledge. Foundation for Water Research FR/R0014
8. Barry M. (2003) Corporate social responsibility – unworkable paradox or sustainable paradigm? Proc ICE Engineering Sustainability 156. Sept Issue ES3 paper 13550. p 129-130
9. Blackmore J M., Plant R A J. (2008). Risk and resilience to enhance sustainability with application to urban water systems. J. Water Resources Planning and Management. ASCE. Vol. 134, No. 3, May.
10. Bogle D. (2010) UK's engineering Council guidance on sustainability. Proc ICE Engineering Sustainability 163. June Issue ES2 p61-63
11. Brown R R., Ashley R M., Farrelly M. (2011). Political and Professional Agency Entrapment: An Agenda for Urban Water Research**.** Water Resources Management. Vol. 23, No.4. European Water Resources Association (EWRA) ISSN 0920-4741.
12. Brugnach M., Dewulf A., Pahl-Wostl C., Taillieu T. (2008) Toward a relational concept of uncertainty: about knowing too little, knowing too differently and accepting not to know. Ecology and Society 13 (2): 30
13. Butler D., Davies J. (2011). Urban Drainage. Spon. 3rd Ed.
14. Cavill S., Sohail M. (2003) Accountability in the provision of urban services. Proc. ICE. Municipal Engineer 156. Issue ME4 paper 13445, p235-244.
15. Centre for Water Sensitive Cities (2012) Blueprint for a water sensitive city. Monash University.
16. Charles J A. (2009) Robert Rawlinson and the UK public health revolution. Proc ICE Eng History and Heritage. 162 Nov. Issue EH4. p 199-206

What the student will learn? To develop an understanding of:

1. The impact which Civil Engineering projects have on the Society at large and on the global arena and using resources efficiently and effectively.
2. The extent of Infrastructure, its requirements for energy and how they are met: past, present and future
3. The Sustainability of the Environment, including its Aesthetics,
4. The potentials of Civil Engineering for Employment creation and its Contribution to the GDP
5. The Built Environment and factors impacting the Quality of Life
6. The precautions to be taken to ensure that the above-mentioned impacts are not adverse but beneficial.
7. Applying professional and responsible judgement and take a leadership role;

SYLLABUS FOR BASKET OF ELECTIVE COURSES OF ELECTED TRACKS

IMPORTANT NOTE: Select subject from each track for respective elective. ***Suggested credit for any course is 3. Prerequisites are to be decided by the concerned faculty keeping in mind the track/thread/stream of courses taken by the student earlier.***

PEC-I

Pavement Materials. Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders.Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests,Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. bituminous mix design methods and specifications.Weathering and Durability of Bituminous Materials and Mixes.Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.
Prerequisite:

Pavement Design. Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements.Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behaviour under transient traffic loads.Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC
Prerequisite:

Public Transportation Systems: Public Transport: Definitions, modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements; Transit Network Planning: Planning Objectives, principles, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations; Transit Scheduling: Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling;Transit Agency and Economics: Organizational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure; Design of Facilities: Design of bus stops, design of terminals – principles of good layout, types of layout, depot location, twin depot concept, crew facilities and amenities.
Prerequisite:

Traffic Engineering and Management: Traffic Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection; Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Determination of design hourly volume; critical hour concept;Highway Capacity: Factors affecting capacity, level of service; Capacity studies - Capacity of different highway facilities including unsignalised and signalised intersections. Problems in Mixed Traffic flow; Case studies; Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions; Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications; Probabilistic Aspects Of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications; Simulation: Fundamental principle, application of simulation techniques in traffic engineering - formulation of simulation models, Case studies. Formulation of system models.
Prerequisite:

Urban Transportation Planning: Urban morphology - Urbanization and travel demand – Urban activity systems and travel patterns – Systems approach – Trip based and Activity based approach - Urban Transportation Planning – Goals, Objectives and Constraints - Inventory, Model building, Forecasting and Evaluation - Study area delineation – Zoning - UTP survey; Trip generation models – Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models, Gravity model and Opportunity modes; Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior; Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems; Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – urban development planning policy -

Case studies.

Geometric Design of Highways: Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design; Design Controls: Topography, vehicle characteristics and design vehicle, driver characteristics, speed, traffic flow and capacity, levels of service, pedestrian and other facilities, environmental factors; Design Elements: Sight distances, Horizontal alignment - design considerations, stability at curves, super elevation, widening, transition curves; curvature at intersections, vertical alignment - grades, ramps, design of summit and valley curves, combination of vertical and horizontal alignment including design of hair pin bends, design of expressways, IRC standards and guidelines for design problems; Cross Section Elements: Right of way and width considerations, roadway, shoulders, kerbs traffic barriers, medians, frontage roads; Facilities for pedestrians, bicycles, buses and trucks, Pavement surface characteristics - types, cross slope, skid resistance, unevenness; Design Considerations: Design considerations for rural and urban arterials, freeways, and other rural and urban roads; Design Of Intersections: Characteristics and design considerations of at-grade intersections;; Rotary intersections; Grade separations and interchanges -; Design of Parking lots
Prerequisite:

Airport Planning and Design:Aircraft characteristics; Aircraft performance characteristics: Airport planning and air travel demand forecasting: Airport Site Selection; Geometric Design of the Airfield: Determination of Runway Capacity and Delay - Taxiway and Gate Capacity - Holding Aprons - Terminal Aprons – Airport drainage - Function of Airport Passenger and Cargo Terminal - Design of Air Freight Terminals - Airport access - Airport Landside planning - Capacity; Air Traffic Management: Navigational aids: ground based systems, satellite based systems – Air traffic control and surveillance facilities – Airfield lighting - air traffic management.
Prerequisite:

Railway Engineering. Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses; rails, sleepers; ballast; subgrade and formation, rack fittings and fastenings, creep of rails, geometric design of track, curves and super-elevation, points and crossings, track junctions and simple track layouts; rail joints and welding of rails; track maintenance, track drainage; modern methods of track maintenance, rehabilitation and renewal of track; tractive resistance and power, railway stations and yards; railway tunneling; signaling and interlocking; maintenance of railways and high speed trains.
Prerequisite:

Intelligent Transportation Systems: Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location

(AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System; ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS); ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management; Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.
Prerequisite:

Pavement Construction and Management: Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers and their choice; Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints; Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications; Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid Resistance. Structural evaluation of pavements - nondestructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques; Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, life cycle costing,
Prerequisite:

Port and Harbour Engineering: Harbour Planning: Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations; Docks and Repair Facilities: Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, Harbour docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates;

Navigational Aids: Requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar; Dredging and Coastal Protection: Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile; Port facilities: Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities. Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways.
Prerequisite:

High Speed Rail Engineering. Development, engineering, design and construction of high-speed rail (HSR) passenger transport systems with particular emphasis on the unique engineering elements of HSR technology. Key elements of HSR systems and subsystems including: core systems (trains, power, signal, communication and control), track system and civil infrastructure (earthwork, bridges, viaducts and tunnels). Also covered are basic design and construction of HSR stations and rolling stock maintenance facilities.
Prerequisite:

Transportation Economics: Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation; Transportation costs - Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing. Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity; Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs. Economics of traffic congestion - Pricing policy; Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects; Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.
Prerequisite:

Infrastructure Planning and Management: Introduction: Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, bases for quantification of demand and supply of various types of infrastructure, Indian scenario in respect of adequacy and quality. Infrastructure Planning: Goals and objectives of infrastructure planning; Identification and quantification of the casual factors influencing the demand for infrastructure; review and application of techniques to estimate supply and demand for infrastructure; use of econometric, social and land use indicators and models to forecast the demand and level of service of infrastructure and its impact on land use; critical review of the relevant forecasting techniques; infrastructure planning to identify and prioritize preferred areas for development; Integration of strategic planning for infrastructure at urban, regional and national levels; case studies in infrastructure planning. Infrastructure Management: Concepts, Common aspects of urban and rural

infrastructure management systems; pavement and bridge management systems, Integrated infrastructure management, Case studies; Emerging trends in infrastructure: Overview of Public-Private Sector Participation in infrastructure projects, Understanding stakeholders' concerns, regulatory framework, risk management in infrastructure projects, public policy for infrastructure Sectoral Overview: Highways, railways, waterways, airports, urban and rural infrastructure: roads, housing, water supply, sanitation – case study examples.
Prerequisite:

PEC-II

Construction Productivity. Definition of Productivity, Impact of productivities on construction duration and costs; Measuring productivities of construction equipment, Staff and Labour and typical benchmarks for the same; Productivity analysis from Daily Progress Reports; Lean Construction concepts of Value Adding activities, Non-Value Adding Activities and Non-Value Adding but Necessary Activities; Productivity measurements by special Lean Construction-oriented field methods such as Work Sampling, Takt time analysis, Foreman Delay Surveys; Productivity improvement measures such as Value Stream Mapping, Location-Based management Systems, 5S, good Housekeeping, etc.; use of specialist software such as Vico for productivity studies
Prerequisite:

Building Construction Practice. Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry – Bond in masonry - concrete hollow block masonry – flooring – damp proof courses – construction joints – movement and expansion joints – pre cast pavements – Building foundations – basements – temporary shed – centering and shuttering – slip forms – scaffoldings – de-shuttering forms – Fabrication and erection of steel trusses – frames – braced domes – laying brick — weather and water proof – roof finishes – acoustic and fire protection; Sub Structure Construction- Techniques of Box jacking – Pipe Jacking -under water construction of diaphragm walls and basement-Tunnelling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points -Dewatering and stand by Plant equipment for underground open excavation; Super Structure Construction- Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavy decks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors - Erection of articulated structures, braced domes and space decks;
Prerequisite:

Construction Project Planning& Systems. Definition of Projects; Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks.PERT-Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion. Allocation of Resources- materials, equipment, staff, labour and finance; resource levelling and optimal schedules; Project organisation, documentation and reporting systems. Control & monitoring; Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management; Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning,

organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and levelling. Common Good Practices in Construction; *Project Monitoring & Control*- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.
Prerequisite:

Construction Cost Analysis. Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts and statistical measurements of the factors involved in direct costs, general overhead costs, cost markups and profits; and the fundamentals of cost recording for construction cost accounts and cost controls.
Prerequisite:

Sustainable Construction Methods. Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls); Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges; Identification of cutting edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity. Examination of the current LEED for New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam.
Prerequisite:

Construction Engineering Materials. Design, production, application, specification, and quality control of construction materials unique to civil engineering. Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals; Structural Steel, High Tensile Steel, Carbon Composites; Plastics in Construction; 3D printing; Recycling of Construction & Demolition wastes
Prerequisite:

Contracts Management: Contract Management – Introduction, Importance of Contracts, Overview of Contract Management, Overview of Activities in Contract Management; Planning and People- Resource Management; Types of Contracts, Parties to a Contract; Contract Formation, Formulation of Contract, Contract Start-Up, Managing Relationships; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Notices under contracts; Conventional and Alternative Dispute Resolution methods. Various Acts governing Contracts; Contract Administration and Payments- Contract Administration, Payments; Contract Management in Various Situations- Contract Management in NCB Works, Contract Management in ICB Works Contracts, Contract of Supply of Goods-Design, Supply and Installation Contracts, Contract Management in Consultancy,; Managing Risks and Change- Managing Risks, Managing Change; Contract Closure and Review-Ending a Contract, Post-Implementation Review; Legal Aspects in Contract Management-Contract Management Legal View, Dispute Resolution, Integrity in Contract Management; Managing Performance- Introduction, Monitoring and Measurement.

Construction Equipment & Automation*:*Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; plastering machines; Prestressing jacks and grouting equipment; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities; Use of Drones for spread out sites; Use of robots for repetitive activities
Prerequisite:

Repair & Rehabilitation of Structures. Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration; Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion – Effects of cover thickness; Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes; Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection; Repair, Rehabilitation and Retrofitting of Structures- Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; Non-Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs.Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods – Case studies.
Prerequisite:

PEC-III

Ecological Engineering. Characteristics of rivers and lakes which affect the management of domestic and industrial wastewaters; chemical hazards assessment, surveillance and biomonitoring, and review of regulations governing effluents.
Prerequisite:

Environmental Systems. Introduction to the concepts and applications of environmental systems analysis. Application of mathematical programming and modeling to the design, planning and management of engineered environmental systems, regional environmental systems, and environmental policy. Economic analysis, including benefit-cost analysis and management strategies. Concepts of tradeoff, non- inferior sets, single and multi-objective optimization. Practical application to case studies to convey an understanding of the complexity and data collection challenges of actual design practice.
Prerequisite:

Transport of water and wastewater. The objective of the course is to make students gain insight into how the water and wastewater gets transported through conduits and open channels, and use the same for the design, operation and maintenance of these systems. Water Supply Systems: Storage requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distribution systems, distribution and balancing reservoirs, pipe materials, appurtenances, design for external loads, maintenance and operation. Sanitary Sewerage Systems: Flow estimation, sewer materials, hydraulics of flow in sewers, sewer lay out, sewer transitions, materials for sewers, appurtenances, manholes, sewer design, conventional and model based design, sewage pumps and pumping stations, corrosion prevention, operation and maintenance, safety. Storm water Drainage Systems: Drainage layouts, storm runoff estimation, hydraulics of flow in storm water drains, materials, cross sections, design of storm water drainage systems, inlets, storm water pumping, operation and maintenance

Environmental Laws and Policy. Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law, Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc., Introduction to trade and environment. International environmental laws, Right to Environment as Human Right, International Humanitarian Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.

Physico-Chemical Processes for water and wastewater treatment. The Objective of this course is to provide an in depth understanding of physical and physico-chemical processes used for water and wastewater treatment systems and to provide capability to design such systems. Water purification in natural systems, physical processes, chemical processes and biological processes. Primary, secondary and tertiary treatment. Unit operations, unit processes. Aeration and gas transfer**.** Sedimentation, different types of settling, sedimentation tank design. Coagulation and flocculation, coagulation processes, stability of colloids, destabilization of colloids, destabilization in water and wastewater treatment, transport of colloidal particles, design aspects. Filtration: filtration processes, Hydraulics of flow through porous media, Rate control patterns and methods, Filter effluent quality parameters, mathematical model for deep granular filters, slow sand filtration, rapid sand filtration, pre-coat filtration, design aspects. Disinfection: Types of disinfectants, Kinetics of disinfection, chlorination and its theory, Design of Chlorinators. Precipitation: Hardness removal, Iron, Mn, and heavy metal removal; Adsorption, adsorption equilibria and adsorption isotherm, rates of adsorption, Sorption kinetics in batch reactors, continuous reactors, factors affecting adsorption. Ion Exchange-exchange processes, materials and reactions, methods of operation, Application, design aspects. Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis

Biological processes for contaminant removal. Understanding of basics of microbiology, metabolism and energetic, bio kinetic parameter, reactors and reactor analyses. Characterization of waste. Aerobic, anaerobic and anoxic systems. Suspended and attached growth biological systems. Activated Sludge processand process modifications, Process design considerations, Treatment Ponds and aerated Lagoons, aerobic pond, facultative pond, anaerobic ponds, polishing ponds, constructed wet lands etc. Attached Growth Biological Treatment Systems, Trickling Filters, Rotating Biological Contactors, Activated Biofilters, Moving bed biological reactor (MBBR), Sequential Batch reactors (SBR), Membrane Biological Reactors (MBR) etc. Anaerobic processes, Process fundamentals, Standard, high rate and hybrid reactors, Anaerobic filters, Expanded /fluidized bed reactors, Upflow anaerobic sludge blanket reactors, Performance and design aspects, Expanded granular bed reactors, Two stage/phase anaerobic reactors. Sludge Digestion, anaerobic digestion, aerobic digestion

Rural water supply and onsite sanitation systems: Attributes of water supply systems, drinking water quality. Relationships between diseases and water quality, hygiene and sanitation. Need for water treatment. Point of use water treatment systems, filters, bio-sand filters, disinfection systems for rural areas, chlorination, Solar disinfection systems, removal of arsenic, fluoride and iron.Onsite sanitation systems: Nexus between water quality and sanitation. Importance of hydrogeology on selection of onsite sanitation systems, Design of Septic tanks, single pit and double pit toilets. Small bore systems, bio digesters, reed beds, constructed wetlands, sludge/septage management systems.

Water and Air Quality Modelling: Introduction to Mathematical Models: water quality model development, calibration and verification cost: benefit analysis using models, Model requirements and limitations. D.O. Models for Streams: Dissolved oxygen model for streams sources and sinks of dissolved oxygen estimation of system parameters Streeter Phelps model oxygen 'sag' curve-determination of deoxygenation and re-aeration coefficients- Benthal oxygen demand mass transport mechanisms- Models for Estuary and Lakes: Physical

chemical and biological processes in estuaries; Air quality models: Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Stack height computation, Regional air quality models, Source inventories and significance .

Solid and hazardous waste management. Solid Wastes: Origin, Analysis, Composition and Characteristics. Integrated Solid Waste Management System: Collection, Storage, Segregation, Reuse and Recycling possibilities, Transportation, Treatment / Processing and Transformation Techniques, Final Disposal. Management of: Municipal, Biomedical, Nuclear, Electronic and Industrial Solid Wastes and the rules and regulations. Introduction to Hazardous wastes, Definition of Hazardous waste, The magnitude of the problem; Hazardous waste: Risk assessment, Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Transportation of hazardous waste, Physical, chemical and biological treatment, Ground water contamination, Landfill disposal, Current Management Practices, Environmental audit, Pollution Prevention, Facility Development and operation, Site Remediation: Quantitative risk assessment, site and subsurface characterization, Containment, remedial alternatives.

Air and Noise Pollution and Control. Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer disturbance, Greenhouse effect. Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations, control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality. Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices. Noise control methods.

Environmental impact assessment and life cycle analyses. Evolution of EIA: Concepts of EIA methodologies, Screening and scoping; Rapid EIA and Comprehensive EIA; General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis, Definition of Risk, Matrix Method. Checklist method, Fault tree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities; Environmental Legislation; Introduction to Environmental Management Systems; Environmental Statement - procedures; Environmental Audit: Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control; Case Studies on EIA.

Sustainable Design Engineering & Technology. Quantitative sustainable design (QSD) and how to navigate engineering decision-making. Economic (life cycle costing, techno-economic assessment) and environmental (life cycle assessment: LCA) sustainability assessments, and how to link these tools to design decisions under uncertainty. Design of engineered technologies individually and in teams, with special attention to water infrastructure and bioenergy production. Semester-long design project that includes components from two of the following three CEE sub-disciplines: environmental, hydraulic, geotechnical.
Prerequisite:

PEC-IV

Design of Hydraulic Structures/Irrigation Engineering: This course should discuss key issues in designing irrigation channels and hydraulic structures used in irrigation systems
Estimation of crop water requirement; Design of lined and unlined channels; Analysis for surface and sub-surface flow at hydraulic structures; Design of barrages and weirs; Design of Head and cross regulators; Design of canal falls, transitions and cross drainage works; Design principles for gravity and earthen dams.

Pipeline Engineering: The course should cover key issues for designing and operating pipelines for transmission and distribution of water; Analysis of flow in water transmission and water distribution systems (pump & gravity); optimal design and operation of systems for achieving different goals (including latest tools available for optimization); Extended period simulations, Software for WDN analysis and design, Rehabilitation of pipeline systems; Water auditing, online monitoring and control, leak and burst detection; transient analysis and surge protection; Appurtenances (valves / flow meters etc.); Selection of pipe material; Jointing details; Pipe laying and testing; Structural design for buried and surface mounted pipes
Pre-Requisite: Basic course in Hydraulic Engineering.

Unsteady Open Channel Flow: This course should discuss how to analyze for unsteady flows in open channels; Derivation of 1-D and 2-D shallow water flow equations; Consideration for non-hydrostatic pressure distribution; Basics of numerical methods: Finite-Difference and Finite Element Methods; Latest shock capturing Finite Volume methods for solving 1-D and 2-D shallow water flow equations; Dambreak flow; Flood routing in large channel networks, Flood routing in compound channels; Flood routing in channels with flood plains, Surface irrigation flow modeling
Pre-Requisite: Basic course in Hydraulic Engineering

River Engineering: Knowledge about river behavior is essential for practicing hydraulic and water resources engineers. River Morphology (Bars; Bends and Meanders, Thalweg; Braiding; Bifurcations etc.); Sediment Transport Mechanics (Bed forms, Bed Load transport, Transport of suspended sediment, Critical Shear stress, Sediment Transport Equations); Aggradation and Degradation; Local Scour at Bridge Piers and other Hydraulic Structures. Measurements in Rivers (Stage measurements, Channel geometry, Discharge, Sediment samplers and suspended and bed load measurement), Physical river Models (fixed and movable bed models; sectional models, distorted Models), Mathematical models for aggradations, degradation and local scour, River Protection and Training Works (Revetments, Dikes, Gabions, Spurs, Bank Protective measures and Bed control structures), Design of river training and flood protection structures, Diversion and Cofferdams; River regulations systems; Dredging and Disposal, River restoration

Hydraulic Modeling: The main objective of this course is to introduce various concepts which will help in designing physical hydraulic models. Basics of Hydraulic Modelling (similarity mechanics, model laws, distinction between numerical and hydraulic models, classification of hydraulic modelling, materials used in the model, scale effect, design, construction, operation and interpretation of the results); Role of instrumentation and data processing; Gravity dominated models (modelling of energy dissipaters, overflow spillways, siphon spillways, bridge piers, vortex formation, cavitation, flow induced vibrations); Gravity

friction models: (pumped flow models, ship models, surge tank models); Friction dominated models; River models with fixed and mobile bed; Basin and reservoir models; Tidal models with fixed and mobile bed; estuarine models; harbor and breakwater models, models of offshore structures; Hybrid and Analogue models; Scope and limitations of hydraulic modelling, complementary aspects of numerical and hydraulic modelling.

Basics of Computational Hydraulics. Derivation of governing equations for flow and transport in surface and sub-surface (saturated and unsaturated flow); Equations for reactive transport; Coupled surface and sub-surface flow models; Basics of finite difference, finite element and finite volume methods (consistency, stability, convergence, order of accuracy, computational efficiency); application of numerical methods for solving flow and transport equations, fully coupled and iteratively coupled models; Model simplification, Parameter estimation (Model calibration and validation), Computational Fluid Dynamics (CFD) software for three-dimensional turbulent flow modeling, Software for sub-surface flow simulation

Transients in Closed Conduits: This course should cover key issues for understanding the unsteady flow in pipes (water hammer) and designing for surge protection**;** Differential equations for unsteady pipe flow; Characteristic method for solution; Formulation of boundary conditions; transients in pumping mains (power failure; pump start up); transients in penstocks of hydro-electric schemes; analysis for transient control using surge tanks; air chambers; air valves; pressure regulating valves etc.; Emphasis should be on development of computer programs for transient analysis; awareness about commercially available software for transient analysis
Pre-Requisite: Basic course in Hydraulic Engineering

Urban Hydrology and Hydraulics. Hydraulic analysis and design of urban, highway, airport, and small rural watershed drainage problems; discussion of overland and drainage channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; runoff for highways, airports, and urban areas; design of drainage gutters, channels, sewer networks, and culverts.
Prerequisite:

Groundwater. Physical properties of groundwater and aquifers, principles and fundamental equations of porous media flow and mass transport, well hydraulics and pumping test analysis, role of groundwater in the hydrologic cycle, groundwater quality and contamination.
Prerequisite:

PEC-V

Water Quality Engineering. Fundamental theory underlying the unit processes utilized in the treatment of water for domestic and industrial usage, and in the treatment of domestic and industrial wastewaters.

Surface Hydrology. Study of descriptive and quantitative hydrology dealing with the distribution, circulation, and storage of water on the earth's surface; discusses principles of hydrologic processes and presents methods of analysis and their applications to engineering and environmental problems.
Prerequisite:

Environmental Fluid Mechanics. Incompressible fluid mechanics with particular emphasis on topics in analysis and applications in civil engineering areas; primary topics include principles of continuity, momentum and energy, kinematics of flow and stream functions, potential flow, laminar motion, turbulence, and boundary-layer theory.
Prerequisite:

Water Resources Field Methods. Scientific principles of measurement technologies and protocols used for water-resources measurements and experimental design of field-scale water-resources and environmental studies. Planning field studies; instruments and protocols for surface-water, ground-water, and water-quality sampling; description of data quality. One-half-day laboratory field trips to streamflow monitoring stations and groundwater monitoring wells nearby.

PEC-VI

Reliability Analysis of Structures. Role of reliability in civil engineering; Historical background, random events, random variables, model uncertainty; Common probabilistic models; Important statistical parameters and their estimations, normal, lognormal, extreme value distribution; Fundamental concept of structural reliability; Derivation of stress-strength interface equation, graphical representation, Cornel reliability index, reliability and failure probability computations for simple linear functions; Second moment concepts, First order second moment theory, Hasofer-Lind transformation, Linear and non-linear limit state functions, Solution schemes, geometric interpretation of solution scheme, Rackwitz-Fiessler transformation, First order reliability method; Stochastic models for material strength and loads, Reliability assessment of structural component and simple civil engineering structures.
Prerequisite:

Engineering Risk & Uncertainty. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Development of stochastic concepts and simulation models and their relevance to real design and decision problems in various areas of civil engineering.
Prerequisite:

Decision and Risk Analysis. Development of modern statistical decision theory and risk analysis, and application of these concepts in civil engineering design and decision making; Bayesian statistical decision theory, decision tree, utility concepts, and multi-objective decision problems; modeling and analysis of uncertainties, practical risk evaluation, and formulation of risk-based design criteria, risk benefit trade-offs, and optimal decisions.
Prerequisite:

Engineering Materials for Sustainability. Environmental impact of materials; life-cycle assessment; material selection to optimize performance; design, evaluation, and production of green construction materials.
Prerequisite:

Concrete Materials. Examines the influence of constituent materials (cements, aggregates and admixtures) on the properties of fresh and hardened concrete; Recycled aggregates recovered from construction and demolition wastes; M-Sand; Light-weight aggregates; Use of Fly Ash in concrete; Fibre-reinforced concrete with various types of metallic and non-metallic fibres; various types of concrete such as Self Compacting Concrete, High Performance Concrete, etc.; mix design; handling and placement of concrete; Effect of revibration of concrete; behavior of concrete under various types of loading and environment; test methods. Laboratory practice is an integral part of the course.
Prerequisite:

Wood Structures. Mechanical properties of wood, stress grades and working stresses; effects of strength- reducing characteristics, moisture content, and duration of loading and causes of wood deterioration; glued- laminated timber and plywood; behavior and design of connections, beams, and beam-columns; design of buildings and bridges; other structural applications: trusses, rigid frames, arches, and pole-type buildings; and prismatic plates and hyperbolic paraboloids. Prerequisite:

Masonry Structures. Introduction to analysis, design and construction of masonry structures. Mechanical properties of clay and concrete masonry units, mortar, and grout. Compressive, tensile, flexural, and shear behavior of masonry structural components. Strength and behavior of unreinforced bearing walls. Detailed design of reinforced masonry beams, columns, structural walls with and without openings, and complete lateral-force resisting building systems.
Prerequisite:

Structural Analysis. Direct stiffness method of structural analysis; fundamentals and algorithms; numerical analysis of plane trusses, grids and frames; virtual work and energy principles; introduction to the finite element method for plane stress and plane strain.
Prerequisite:
Analysis of building frames; Kani's, moment distribution and other methods and Approximate methods; Stiffness matrix method; Application to simple problems of beams and frames; Flexibility matrix method; Application to simple problems of beams and frames; Moving loads for determinate beams; Different load cases, Influence lines for forces for determinate beams; Influence lines for pin-jointed trusses; Influence lines for indeterminate beams using Muller Breslau principle. Influence lines for Arches and stiffening girders.

Advanced Structural Analysis. Elasticity: Introduction, Components of strain and strain, Hooke's law, Plane stress and plane strain, Equations of equilibrium and compatibility, Boundary conditions, Two dimensional problems in rectangular and polar coordinates, Bending of simple and cantilever beams; Model Analysis: Structural similitude, Direct and indirect model analysis, Model material and model making, Measurement for forces and deformations; Introduction to Finite element method for structural analysis; Review of principle of virtual work, Ritz method, Discretization of domain, Basic element shape,
Discretization process; Application of finite element method to one and two- dimensional plane stress strain elements.
Prerequisite:

Structural Analysis by Matrix Methods. Analysis of truss and frame structures using flexibility and stiffness methods of matrix analysis; computer applications.
Prerequisite:

Structural Mechanics. Beams under lateral load and thrust; beams on elastic foundations; virtual work and energy principles; principles of solid mechanics, stress and strain in three dimensions; static stability theory; torsion; computational methods.
Prerequisite:

Reinforced Concrete. Study of the strength, behavior, and design of reinforced concrete members subjected to moments, shear, and axial forces; extensive discussion of the influence of the material properties on behavior.
Prerequisite:

Concrete Technology. Concrete; Properties of ingredients, tests, Production of concrete, mixing, compaction curing, Properties of fresh concrete; Defects in Concrete, Concrete

additives.; Behavior of concrete in tension and compression, shear and bond, Influence of various factors on test results, Time dependent behavior of concrete -creep, shrinkage and fatigue; Concrete mix design; Proportioning of concrete mixes, basic considerations, cost specifications, factors in the choice of mix proportion, different method of mix design. Quality control, Behavior of concrete in extreme environment; temperature problem in concreting, hot weather, cold weather and under water conditions, Resistance to freezing, sulphate and acid attack, efflorescence, fire resistance; Inspection and testing of concrete-Concrete cracking, types of cracks, causes and remedies Non-destructive tests on concrete; Chemical tests on cement and aggregates; Special concrete; types and specifications, Fibre reinforced and steel Fibre reinforced concrete, Polymer concrete, Use of admixtures; Deterioration of concrete and its prevention Repair and rehabilitation.
Prerequisite:

Design of Steel Structures. Properties of materials; loads and stresses, Design of semi-rigid, rigid and moment resistant connections; Built-up sections Design of tension members subjected to axial tension and bending, splicing of tension member, Design of compression members, Beam-column connections, Design of columns and their bases Design of flexural members and Plate girder; loads, specification and design Industrial buildings; loads, design of purlins, trusses, bracings; gantry girders; Introduction to Plastic analysis; Simple cases of beams and frames; All design steps/process to as per the most recent BIS code of practices
Prerequisite:

Metal Structure Behavior. Introduction to the design of metal structures; behavior of members and their connections; and theoretical, experimental, and practical bases for proportioning members and their connections.
Prerequisite
Metal members under combined loads; connections, welded and bolted; moment- resistant connections; plate girders, conventional behavior, and tension field action.
Prerequisite:

Bridge Engineering. General; classification of bridges, site selection, geometric and hydraulic design consideration, loading standards for highway and railway bridges, general design consideration; optimum spans; Concrete bridges: culverts; Slab, T-beam, box girder bridges, balanced cantilever bridge, cable stayed bridge, extrados bridges; arch bridge; Special requirements for Prestressed Concrete bridges; Steel bridges: plate girder bridge, truss bridge, suspension cable bridge, cable stayed bridge; Substructures: design of piers and abutments, pile and well foundations, bearings and expansion joints, special wearing coats; seismic design considerations; Aerodynamic stability considerations; special durability measures; provisions for inspection and maintenance;
Prerequisite:

Industrial Structures. Industrial steel building frames: Types of frames, bracing, crane girders and columns, workshop sheds, trussed bents, Pressed steel tank, circular tank; Transmission and Communication towers: Types and configuration, Analysis and design; Chimneys; Loads and stresses in chimney shaft, Earthquake and wind effect, Stresses due to temperature difference, combined effect of loads and temperature, temperature. Design of chimney; Silos and Bunkers; Jassen's theory, Airy's theory, Shallow and deep bins, Rectangular bunkers with slopping bottom, Rectangular bunkers with high side walls; Steel stacks; introduction, force acting on a steel stack, design consideration, design example of stacks; Concrete Shell Structures: Folded plate and cylindrical shell structures; Introduction, structural behaviour of long and short shells, beam and arch action, analysis and design of cylindrical shell structures, Analysis and design of folded plates; Machine foundations; introduction, machine vibration, structural design of foundation to rotary machines, impact machines, vibration characteristics, design consideration of foundation to impact machine, grillage, pile and raft foundation.

Design of Structural Systems. The whole structural design process including definition of functional requirements, selection of structural scheme, formulation of design criteria, preliminary and computer- aided proportioning, and analysis of response, cost, and value.
Prerequisite:

Structural Dynamics. Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multi-degree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; and introduction to systems with distributed mass and flexibility.

Earthquake Engineering. Theory of Vibrations; Concept of inertia and damping - Types of Damping - Difference between static forces and dynamic excitation - Degrees of freedom - SDOF idealization - Equations of motion of SDOF system for mass as well as base excitation - Free vibration of SDOF system - Response to harmonic excitation - Impulse and response to unit impulse - Duhamel integral; Multiple Degree of Freedom System; Two degree of freedom system - Normal modes of vibration - Natural frequencies - Mode shapes - Introduction to MDOF systems - Decoupling of equations of motion - Concept of mode superposition (No derivations); Elements of Seismology; Causes of Earthquake - Geological faults - Tectonic plate theory - Elastic rebound – Epicentre; Hypocentre - Primary, shear and Raleigh waves - Seismogram - Magnitude and intensity of earthquakes - Magnitude and Intensity scales - Spectral Acceleration - Information on some disastrous earthquakes; Response of Structures to Earthquake;Response and design spectra - Design earthquake - concept of peak acceleration - Site specific response spectrum - Effect of soil properties and damping - Liquefaction of soils - Importance of ductility - Methods of introducing ductility into RC structures Design Methodology IS 1893, IS 13920 and IS 4326 - Codal provisions - Design as per the codes - Base isolation techniques - Vibration control measures - Important points in mitigating effects of earthquake on structures
Prerequisite:

Civil Engineering Design. Concept of design and its contribution to the quality of life; Civil Engineering Design, the role of geomatics, the environment, and scientific laws in design; Introduction to the design of buildings and Civil Engineering Infrastructure, site appraisal; Risk and vulnerability in design; Health and safety in Civil Engineering Design,

environmental impact assessment; Civil Engineering drawing, CAD techniques, introduction to GIS techniques.
Prerequisite:
Innovation and creativity in conceptual design; sustainability; health and safety; investigative procedures. The use of analysis, synthesis and optimization in design; project planning, networks and graphs. Design of embankments, dams; drainage design; route location and alignment design of roads; assessment of natural hazard impacts and environmental impacts.
Prerequisite:

Geographic Information Systems and Science. Investigation of geographic information systems (GIS) and science (GIScience) including theory and applications areas. A major portion of the course will be based on use of a current widely-used GIS computer software system. Aspects of geographic data entry and editing, spatial analysis, and map development and display will be considered. Relationship of GIS to the Global Positioning System (GPS) and satellite generated data will be addressed.
Prerequisite:

Modeling and Analysis of Uncertainty. Appreciation and understanding of uncertainties and the conditions under which they occur, within the context of the engineering problem-solving pedagogy of measurements, models, validation, and analysis. Problems and concerns in obtaining measurements; tabular and graphical organization of data to minimize misinformation and maximize information; and development and evaluation of models. Concepts will be supported with computer demonstration. Applications to problems in engineering are emphasized.
Prerequisite:

Systems Engineering & Economics: Introduction to the formulation and solution of civil engineering problems. Major topics are: engineering economy, mathematical modeling, and optimization. Techniques, including classical optimization, linear and nonlinear programming, network theory, critical path methods, simulation, decision theory, and dynamic programming are applied to a variety of civil engineering problems.
Prerequisite:

PEC-VII

Soil Mechanics. Composition and structure of soil; water flow and hydraulic properties; stress in soil; compaction and compressibility of soils; consolidation characteristics, settlement analysis; shear strength of soils; basics of unsaturated soils; experimental measurements.
Prerequisite:
Application of soil mechanics to determine earth pressures, analysis of retaining walls, cuts & excavations and sheet piles, stability of slopes, instrumentation.
Prerequisite:

Reference books:

- Soil Mechanics by Craig R.F., Chapman & Hall
- Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning

On successful completion of this course, the students:

- Should be able to assess soil behavior with the mineralogy present and advanced soil testing of soils such as in thermal, chemical, magnetic fields.
- Should be able to do seepage analysis for finding discharge calculation and stability of structure.
- Should be able design retaining wall subjected to various loads with the knowledge of earth pressure theories.
- Should be able to design sheet pile wall with different methods.
- Should get familiarized with different construction practices for excavation with advantages and disadvantages of each method.
- Should be able to determine the safety analysis for slopes with different methods proposed in the syllabus.
- Should get introduced with the commercial softwares for analyzing the stability of slopes and retaining walls.

Should have knowledge about stress paths and get introduced to critical state soil mechanics

- Should be in a position to do various laboratory experiments to determine design parameters according field application.

Reference books:

- Soil Mechanics by Craig R.F., Chapman & Hall
- Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning

On successful completion of this course, the students:

Foundation Engineering. Analysis and design of foundations, types of foundations, bearing capacity and settlement of foundations; ground movements due to construction; analysis and design of excavations, retaining walls, cuts & excavations and sheet piles, slopes and underground structures.
Prerequisite:
Reference books:

- A. Singh, Modern Geotechnical Engineering, 3rd Ed., CBS Publishers, New Delhi, 1999.
- B.M. Das, Principles of Foundation Engineering, 5th Ed., Thomson Asia, Singapore, 2003.
- N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.

After successful completion of this course, the students would:

- learn about types and purposes of different foundation systems and structures.
- Have an exposure to the systematic methods for designing foundations.
- Be able evaluate the feasibility of foundation solutions to different types of soil conditions considering the time effect on soil behaviour.
- have necessary theoretical background for design and construction of foundation systems.

Geotechnical Design. Subsurface site evaluation; integrated design of retaining walls, foundations, pavements, and materials for airports, highways, dams, or other facilities.
Prerequisite:
Reference books:

- Analysis and Design of Substructures: Limit State Design by Swami Saran

Upon completion of the course, the student would be:

- Well acquainted with the various investigation specifications as per the infrastructure to be build on the proposed site.
- knowing about the properties of materials required for the constructing a desired infrastructure
- familiar with design concepts of various foundation systems
- familiar with design of transportation facilities

Structural Geology. Description, classification, and origin of earth structures. Ways in which the continental crust can deform; link scales of structure from the field, outcrops, hand specimen, thin section by integrating analytical techniques with practical examples. Theoretical and meso to microscale analysis of structures developed through a linked series of lectures and practicals; practical 2D strain analysis; 3D strain concepts; incremental strain, kinematics and polyphase deformations; fold construction and classes; fault evolution and section balancing; fault rock microstructures; fault and fold mechanics, current concepts in plate tectonics, cross-section construction techniques, structural interpretation of seismic data, structural styles in different tectonic settings (thrust and fold belts, rifts, strike and slip, gravity tectonics, inversion), structural geology of reservoir units.
Prerequisite:

Reference books:

- Ghosh, S.K., Structural Geology: Fundamentals and Modern Developments, Elsevier; First edition

On successful completion of this course the students will be able to:

- Acquire knowledge on the geometry and type of structures present in earth.
- Understand and describe the features formed in rocks when subjected to stress.
- Understand the impact of structural geology to active tectonic settings
- Understand micro and macro scale deformation mechanisms (viz., brittle, ductile).
- Portray 2D and 3D strain analysis for various deformation behaviours.
- Interpret graphs and models used in structural geology to understand and demonstrate poly phase deformations.

Offshore Engineering. Introduction to offshore structures, codes of practice, offshore project management, deep water, offshore site investigations, geophysical methods; offshore sediment sampling, in-situ testing, geological aspects; development of design stratigraphies.
Prerequisite:

Rock Mechanics. Determination of physical properties of rocks, failure criterion, rock mass classification, stress around mine openings, strain and displacement of the rock mass, rock reinforcement and support, subsidence.
Prerequisite:

Reference books:

- Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson and J. P. Harrison
- Rock Mechanics: For Underground Mining by Barry H.G. Brady
- Fundamentals of Rock Mechanics, 4th Edition, John Conrad Jaeger, Neville G. W. Cook, Robert Zimmerman

On successful completion of this course the students will be able to:

- Define the properties (viz., physical, mechanical) of rocks and failure criterion of rock mass.
- Use engineering rock mass classification (RMR, Q-system, RQD)
- Analyse the stress distribution insitu and around an opening in underground structures (viz., mine openings, tunnels).
- Determine the relation between strain and displacement components of rockmass.
- Perform field Instrumentation techniques and laboratory studies.
- Understand the fundamentals of ground subsidence.

Environmental Geotechnology. A consideration of technical and scientific aspects of key geo-societal issues. Case studies and analysis of current and historic databases will be used to illustrate topics including, but not limited to, impact of climate change, energy resources, water and soil pollution, and health risks posed by heavy metals and emerging pollutants.
Prerequisite:
Reference books:

- Introduction to Environmental Geotechnology by Hsai – Yang Fang
- CDEEP, IITB video lectures on course CE 488 and CE 641 by Prof. D. N. Singh

Upon successful completion of this course, the student would:

- Have an exposure to interdisciplinary issues pertaining to environment and geotechnical engineering
- Be trained to develop sustainable and environmentally sound solutions for geotechnical problems
- Understand the relevance of various legal aspects involved in addressing environmental consequences associated with geotechnical issues

Ground Improvement Techniques. Introduction, ground modification by vibro-replacement, stone columns, preloading and prefabricated drains, Reinforcedearth structures, Introduction to geotextiles and geomembranes, applications of geotextiles, design methods using geotextiles, geogrids, geonets, geomembranes, geotubes, grouting, deep mixing, PVDs, vacuum consolidation.
Prerequisite:
Reference books:

- Principles and Practice of Ground Improvement by Jie Han
- Ground Improvement Techniques by P. Purushothama Raj

Upon successful completion of this course, the students would:

- gain competence in properly devising alternative solutions to difficult and earth construction problems and in evaluating their effectiveness before, during and after construction.
- understand different approaches to the ground modification.

- Be trained to develop sustainable and environmentally sound solutions for geotechnical problems
- Understand the relevance of various legal aspects involved in addressing environmental consequences associated with geotechnical issues

PEC-VIII

Design of Concrete Structures. Study of the strength, behavior, and design of indeterminate reinforced concrete structures, Load and stresses, load combinations, Working stress and limit state approach. Analysis and design of sections in bending – working stress and limit state method, Rectangular and T-sections, Beams with reinforcement in compression, One-way slab. Design for shear and bond, Mechanism of shear and bond failure, Design of shear using limit state concept, Development length of bars; Design of sections in torsion. Design of two-way slabs; Design of flat slab – direct method; Circular slab; Slab type staircase, Placement of reinforcement in slabs; Voided slab. Design of compression members, Short column, Columns with uni-axial and bi-axial bending; Long columns, use of design charts. Design of foundation; Wall footing, Isolated and combined footing for columns. All designs to be as per the most recent BIS standards as applicable Prerequisite:

Design of continuous beams and building frames, Moment redistribution, Water tank and staging; Introduction, Design criteria, Design of rectangular and circular water tank, Introduction to bridge engineering, Investigation for bridges, IRC loadings, Design of slab culvert; Design of Masonry walls and columns; Pre- stressed concrete, Introduction, pre-stressing system, losses in pre-stress, Design of staircases; All design steps/process to as per the most recent BIS code of practices
Prerequisite:

Prestressed Concrete. Study of strength, behavior, and design of prestressed reinforced concrete members and structures, with primary emphasis on pretensioned, precast construction; emphasis on the necessary coordination between design and construction techniques in prestressing.

Prerequisite:

Syllabus for Open Elective Subjects(OEC)

Four different from the below list:

Intelligent Systems (OEC-1)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1: Fundamental Issues In IS : Defi of AI , History ,Domains AI ,AI problems & State space ,Some examples problems representations like Travelling Salespersons ,Syntax analysis Problem .Basic issues to solve AI problems ,Underlying assumptions ,AI techniques ,Level of model ,Criteria for success ,Control strategies ,DFS,BFS

UNIT 2:Heuristic Search Techniques :Generate & Test ,HillClimbing(simple & stipest),Best first search ,A*, AO*, Constraint satisfaction.

UNIT 3:Knowledge Representation Issues :Systax & Semantic for Propositional logic ,Syntax & Semantic for FOPL, Properties for WFF's, Resolution Basics :conversion to clausal form ,Resolution of proposition logic ,Resolution algorithms for predicates ,Problems with FOPL ,Semantic nets ,Frames ,Scripts

UNIT 4:Reasoning Under Uncertainity :An introduction ,Default reasoning & Closed world assumptions ,Model & Temporal logic ,Fuzzy logic ,Basian Probabilstic inference Dempster Shafer theory ,Heuristic reasoning methods

UNIT 5:Planning & Learning :Planning ,Planning in Situational calculus ,Representation for planning ,Partial order palnning, Partial order palnning algorithm ,Learning by Examples ,Learning by Analogy ,Explanation based learning ,Neurals nets ,Genetics algorithms

Unit 6: Minimax: Game playing strategy ,Natural language processing ,Overview of linguistics , Grammer & Language ,Transformation Grammer ,Basic Parsing Techniques, Expert System ,Architecture of Rule based Expert system ,Non Rule based Expert system.

REFERENCES

1. Artificial Intelligence by Elain Rich & Kevin Knight, Tata McGraw Hills Pub.
2. Principals of AI by Nills .J.Nilsson, Pearson Education Pub.
3. Artificial Intelligence by DAN. W.Petterson. Printice Hall of India
4. Artificial Intelligence by Petrick Henry Winston,
5. Artificial Intelligence by Russel and Norvig, Pearson Education Pub.

Cyber Laws and Security (OEC-2)	
No. of Credits: 3 L T P Total	Total :100 Duration of Exams: 3 Hours

3 0 0 3	

UNIT-I :History of Information Systems and its Importance, basics, Changing Nature of Information Systems, Need of Distributed Information Systems, Role of Internet and Web Services, Information System Threats and attacks, Classification of Threats and Assessing Damages Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices, authentication Service Security, Security Implication for organizations, Laptops Security Basic Principles of Information Security, Confidentiality, Integrity Availability and other terms in Information Security, Information Classification and their Roles.

UNIT-II: Security Threats to E Commerce, Virtual Organization, Business Transactions on Web, E Governance and EDI, Concepts in Electronics payment systems, E Cash, Credit/Debit Cards. Physical Security- Needs, Disaster and Controls, Basic Tenets of Physical Security and Physical Entry Controls, Access Control- Biometrics, Factors in Biometrics Systems, Benefits, Criteria for selection of biometrics, Design Issues in Biometric Systems, Interoperability Issues, Economic and Social Aspects, Legal Challenges

UNIT-III : Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, Finger Prints, Firewalls, Design and Implementation Issues, Policies Network Security- Basic Concepts, Dimensions, Perimeter for Network Protection, Network Attacks, Need of Intrusion Monitoring and Detection, Intrusion Detection Virtual Private Networks- Need, Use of Tunneling with VPN, Authentication Mechanisms, Types of VPNs and their Usage, Security Concerns in VPN

UNIT-IV : Security metrics- Classification and their benefits Information Security & Law, IPR, Patent Law, Copyright Law, Legal Issues in Data mIning Security, Building Security into Software Life Cycle Ethics- Ethical Issues, Issues in Data and Software Privacy Cyber Crime Types & overview of Cyber Crimes

REFERENCES

1. Godbole," Information Systems Security", Willey
2. Merkov, Breithaupt, " Information Security", Pearson Education
3. Yadav, "Foundations of Information Technology", New Age, Delhi
4. Schou, Shoemaker, " Information Assurance for the Enterprise", Tata McGraw Hill
5. Sood,"Cyber Laws Simplified", Mc Graw Hill
6. Furnell, "Computer Insecurity", Springer 7. IT Act 2000

Soft Computing (OEC-3)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-I.Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms- Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-

perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perception Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

UNIT-II.Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.

UNIT-III.Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

UNIT-IV:Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

UNIT-V.Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges. Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets. Genetic Algorithms, Scope & application areas, solution of 0-1Knapsack problem using GA

REFERENCES

1. "Fuzzy sets and Fuzzy Logic: Theory and applications",G.J. Klir,B.Yuan, PHI
2. "Introduction to Fuzzy sets and Fuzzy Logic", M.Ganesh , PHI
3. "An Introduction to Fuzzy Control", D Driankov, H Hellendoorn, M Reinfrank, Narosa Publishing Company
4. " Neural Networks: A classroom approach", Satish Kumar , Tata McGraw Hill
5. Haykin S., "Neural Networks-A Comprehensive Foundations", Prentice-Hall International, New Jersey, 1999.

Web Technology & Information Retrieval(OEC-4)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. Web Server Technology: Web's Robot global access to information, HTML, HTTP, Accessing a web server, publishing on web server, secure HTTP, Secure Sockets Layer, WWW Proxies, IIS, Case study of apache web server.

UNIT 2 .Web search basics:Background and history,Anatomy of WWW, Web characteristics, Spam, The web graph, The Web Search Users, search engines, architecture of search engines, search tools, DNS resolution, The URL frontier, Link analysis, PageRank,

UNIT 3. Web Crawlers: Basics of Web crawling, Various crawling techniques , incremental crawler, parallel crawler, distributed crawlers, focused crawler, agent based crawler, Hidden web Crawler

UNIT 4. Introduction to Information Retrieval: Information retrieval problem, an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval, an inverted index, Bi-word indexes, Positional indexes, Combination schemes

UNIT 5. Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes Index compression: Statistical properties of terms in information retrieval, Heaps' law: Estimating the number of terms, Zipf's law: Modeling the distribution of terms, Dictionary compression, Dictionary as a string, Blocked storage, Postings file compression.

Intellectual Property Rights(OEC-5)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1: Introduction to Intellectual Property: Concept of Intellectual Property, Kinds of Intellectual Property, Economic Importance of Intellectual Property, Indian Theory on Private Property: Constitutional Aspects of Property, Constitutional Protection of Property and Intellectual Property, Economic Development and Intellectual Property Rights Protection

UNIT II: Introduction to Patents: Overview, Historical Development, Concepts: Novelty, Utility, Patentable Subject-matter: Patent Act, 1970- Amendments of 1999, 2000, 2002 and 2005, Pharmaceutical Products and Process and Patent , Protection, Software Patents, Business Method, Protection of Plant Varieties and Farmers' Rights Act, 2001, Patenting of Micro-organism

UNIT III: Procedure of Obtaining of Patents: Concepts of a Patent Application,, Specification: Provisional, Complete, Disclosure Aspects, Claims: Principal, Dependant, Omnibus, Examination of Application, Opposition of Application, Sealing of Patents

UNIT IV: Working of Patents – Compulsory License: Commercialization of Inventions: License- Terms of License Agreement, Assignments of Patents, Revocation of Patents

UNIT V: Infringement: What is Infringement?, How is Infringement determined? Who is an Infringer?, Direct, Contributory and Induced, Defences of Infringement:
5.2.1 Research Exemption, Invalidity, Misuse, Failure to mark, Laches and Estoppel and first sale doctrine

References Books:
1. W.R. Cornish, Intellectual Property, Sweet & Maxwell, London (2000)
2. P. Narayana, Patent Law, Wadhwa Publication
3. Merges, Patent Law and Policy: Cases and Materials, 1996

4. Brian C. Reid, A Practical Guide to Patent Law, 2nd Edition, 1993
5. Brinkhof (Edited), Patent Cases, Wolters Kluwer.
6. Prof. Willem Hoyng & Frank Eijsvogels, Global Patent Litigation, Strategy and Practice, Wolters Kluwer.
7. Gregory Stobbs, Software Patents Worldwide, Wolters Kluwer.
8. Feroz Ali Khader, The Law of Patents- With a special focus on Pharmaceuticals in India, Lexis Nexis Butterworths Wadhwa, Nagpur.
9. Sookman, Computer Law, 1996
10. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009). Eastern Book Company, Lucknow.

Installation Testing & Maintenance of Electrical Equipments(OEC-6)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-1.Installation Of Electrical Equipements: Introduction Unloading of electrical equipment at site Inspection Storage Foundation Alignment of electrical machinesTools/Instruments necessary for installation Inspection, storage and handling of transformer, switchgear and induction motor Preparation of technical report

UNIT-2.Commissioning And Testing:Tests before commissioning of electrical equipment :Electrical and Mechanical test Specific tests on - transformer, induction motor, alternator, synchronous power and electrical power installation Need of gradually loading of Various Tests to be performed after commissioning and before starting the machine Various instruments required for testing Commissioning of switchgear Test report on commissioning and test certificate electrical equipment Preparations before commissioning of power transformer Commissioning- power transformer, three phase induction motor Transformer insulation oil: Properties as per IS, sampling, testing and filtering/purifying, standard tests as per IS Measurement of insulation resistance of different equipments/machines Methods of Drying the winding of electrical equipments and its record Classification and measurement of insulation resistance, Polarization Index Appropriate insulation test for specific purpose Factor affecting

UNIT-3.Maintenance Of Electrical Equipments: General aspect of maintenance, Classification Preventive maintenance-concept, classification, advantages, activities, functions of the Maintenance Department Breakdown maintenance-concept, advantages, activities Reasons of failure of electrical equipment due to poor maintenance Factors for preparing maintenance schedule Frequency of maintenance Maintenance schedule of transformer below and above 1000kVA Maintenance schedule - induction motor, circuit Breaker, overhead line, storage Battery Probable faults due to poor maintenance in transformer, induction motor, circuit breaker, overhead lines and battery

UNIT-4.Trouble Shooting:Causes of fault in electrical equipments- Internal and external Instruments and tools for trouble shooting Common troubles in electrical equipment – DC Machines, AC Machines, Transformers, Circuit- breaker, under-ground cable, electrical Installation Need of trouble shooting chart, advantages Trouble shooting chart – DC Motor,

DC Generator, Transformer, Synchronous Motor, Induction Motor, Circuit-breaker Trouble shooting chart for Domestic appliances- electrical iron, ceiling fan, Washing machine, Air cooler, Vacuum cleaner Fluorescent tube light: Construction, working and troubleshooting chart

UNIT-5.Earthing:Necessity of earthing System earthing : advantage of neutral earthing of generator in power station Equipment earthing: Objective Types of earth electrodesMethods of earthing : plate earthing,pipe earthing and coil earthing Earthing in extra high voltage and underground cable Earthing resistance- factor affecting Determination of maximum permissible resistance of the earthing system Measurement of earth resistance: voltmeter-ammeter method, earth tester method, ohm meter method and earth loop tester method

Define: earthing , grounding and bonding Comparison between equipment earthing and system grounding Earthing procedure - Building installation, Domestic appliances, Industrial premises Earthing in substation, generating station and overhead line

UNIT-6.Electrical Accidents And Safety: Causes of electrical accidents Factors affecting the severity of electrical shock Actions to be taken when a person gets attached to live part Safety regulations and safety measures Indian electricity supply act 1948- 1956 Factory act 1948 Procedure of shut down for sub- station and power lines Permit to work : certificate of (i)requisition for shut down(ii) Permit to work and (iii)Line clear certificate Instruction for the safety of persons working on a job with a permit to work Fire extinguishers- For fixed installation and portable devices

REFERENCE/TEXT BOOKS:

1. Testing Commissioning operation and maintenance of Electrical Equipments by Rao S, Khanna Publication (Latest edition)

2. Installation, commissioning & maintenance of Electrical equipments by Singh TARLOK, S.K.Kataria & Sons, New Delhi, Second edition-2012

3. Electrical power system by Wadhwa C.L., New Age international Publications

Non-Conventional Energy Resources And Utilisation(OEC-7)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. Energy resources and their utilization : Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation. Solar radiations: Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, Flux on a plane surface, Latitude, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Solar altitude angle expression for angle between incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length, Solar radiation data for India.

UNIT 2 :Solar energy: Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing. Solar thermal energystorage, Different systems, solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, Solar Cooking, Green Houses, Solar Power plants, solar photovoltaic system: Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system, PV hybrid System.

UNIT 3 : Biogas: Photosynthesis, Bio gas production, Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation, Fuel properties, Biomass resource development in India. Wind energy: Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development.

UNIT 4 : Electrochemical effects and fuel cells: Principle of operation of an acidic fuel cell, Reusable cells, Ideal fuel cells, Other types of fuel cells, Comparison between acidic and alkaline hydrogen-oxygen fuel cells, Efficiency and EMF of fuel cells, Operating characteristics of fuel cells, Advantages of fuel cell power plants, Future potential of fuel cells, Tidal power: Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy, Limitations of tidal energy conversion systems.Hydrogen Energy: Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel, Development of hydrogen cartridge, Economics of hydrogen fuel and its use.

UNIT 5.Thermoelectric systems: Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma Generators, Geothermal energy: Structure of earth's

interior, Geothermal sites, earthquakes & volcanoes, Geothermal resources, Hot springs, Steam ejection, Principal of working, Types of geothermal station with schematic representation, Site selection for geothermal power plants. Advanced concepts, Problems associated with geothermal conversion. Ocean energy: Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems, Thermoelectric OTEC, Developments of OTEC, Economics. Impact of renewable energy generation on environment, Kyoto Protocol, Cost of electricity production from different energy sources, Energy options for Indian economy.

REFERENCE/TEXT BOOKS:

1. Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata McGrawHill.
2. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of IndiaPvt.Ltd.
3. Ashok V. Desai, "Non conventional Energy", New Age International Publishers Ltd.

Utilization Of Electric Power And Traction(OEC-8)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-I :Illumination : Basic laws of illumination, illumination due to a strip and circular disc, light sources and their characteristics, sources of light, design of lighting schemes, incandescent lamp, sodium lamp, mercury lamp and fluorescent lamp, comparison of various lamps.

UNIT-II. Electric Heating: Principle and application of resistance, induction , dielectric heating and temperature control

UNIT-III. Electric Welding: Resistance welding, arc welding, welding generator and welding transformer, properties of arcing electrode

UNIT-IV.Electrolyting Process: Principles and applications of electrolysis, Faraday's law of electrolysis, electroplating, charging and discharging, capacity and efficiency of battery, defects in battery.

UNIT-V.Electric Traction :Advantages of electric traction, requirements of an ideal traction system, train movement, mechanism of train movement, traction motors, traction motor control, multi unit control, braking of electric motors, thyristor control of electric traction

REFERENCE BOOKS:

1. Utilization of electric energy: Open Shaw Taylor; ELBS
2. Art and Science of Utilization of Electrical energy: H.Pratab; Dhanpat Rai
3. Generation, distribution and utilization of electric power: C.L. Wadhwa; Khanna Publications

Industrial Engineering(OEC-9)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. Basic Concepts of Industrial Engineering: Definition,Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, Time Study - PMTS, determining time, Work sampling, Numerical Problems.

UNIT 2. Productivity, Workforce & Information Management: Productivity Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity, Various methods of Job evaluation & merit rating, Various incentive payment schemes, Organizational & information system structure,

UNIT 3. Manufacturing Cost Analysis: Fixed & variable costs, Direct, indirect & overhead costs, & Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labour, material, overhead in volume, rate & efficiency, Break even Analysis, Numerical Problems.

UNIT 4. Materials Management : Strategic importance of materials in manufacturing industries, Relevant costs, Inventory control models - Economic order quantity

(EOQ), Economic batch quantity (EBQ) with & without shortage, Inventory control systems - P,Q,Ss Systems,determination of order point & safety stock, Selective inventory control - ABC, FSN, SDE, VED,SCM , Numerical Problems.

UNIT 5. Sales Forecasting: Importance, Objectives, Forecasting and Prediction, Types, Classification of Forecasting Methods, Forecast Errors, Costs and Accuracy of Forecasts, Numerical Problems.

UNIT 6. Entrepreneurship : Planning a New Business Venture, Small-scale Industries, Government Policies for Small-scale Industries, Project Identification and Project Formulation, Project Appraisal, Laws Concerning Entrepreneurs, Role of Various National and State Agencies that Render Assistance to Small-scale Industries.

Text Books

1. Production & Operations Management – Chary, TMH, New Delhi.
2. Management Information Systems - Sadagopan, PHI New Delhi.

Reference Books

1. Modern Production Management – S.S. Buffa, Pub.- John Wiley.
2. Operations Management - Schroeder, McGraw Hill ISE.
4. Operation Management - Monks, McGraw Hill ISE.
5.
4. Production & Operations Management - Martinich, John Wiely SE.
6. Industrial & Systems Engineering - Turner, MIZE, CHASE, Prentice Hall Pub.
7.
7. Industrial Engineering & Operations Management – SK Sharma, Pub-S. K. Kataria
8.
7. Industrial Engineering – Ravi Shankar, Galgotia Pub.

Total Quality Management (OEC-10)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1: Introduction : Quality – Basic concepts, dimensions, economics of quality, quality Gurus.TQM: Definition, evolution, journey from inspection to TQM, comparison at different stages, dimensions of TQM, TQM viewpoints, reasons for adopting TQM.

UNIT 2: Introspection to TQM environment: Sphere of TQM, components of TQM, TQM Managing Total Quality, Factors affecting TQM environment, Classification and interaction among factors, Researchers' viewpoint, TQM as a system, steps in TQM implementation, Roadblocks in TQM implementation, Reasons for TQM failure.

UNIT 3:Role of soft options in TQM :Hard vs. Soft factors, Role and expectation of employer, employee, customer and supplier from organization and vice versa. Human factors in TQM, Role of top management commitment, work culture, motivation, coordination, attitude, innovation.

UNIT 4:Quality initiatives in organizations :Role of tools and techniques in TQM, Classification of tools and techniques – Problem identification, Data analysis, Graphical, Creativity, Company wide. Brief description of Quality awards – MBNQA, Deming award, European quality award, Australian quality award.

UNIT 5: TQM Effectiveness : Impact of TQM, Need and difficulty in measuring TQM effect, Parameters governing effect of TQM .

Reference books:

1) "Total Quality Management" by Oakland (Butterworth – Heinamann Ltd.)
2) "Managing for total quality from Deming to Taguchi and SPC" by Logothetis N. (PHI)
3) "Total Quality Control" by Feigenbaum A.V. (MGH)
4) "Total Quality Management" by Besterfield Dale H (Pearson Education)
5) "A slice by slice guide to TQM" by John Gilbert (Affiliated East West Press)
6) "The TQM toolkit – a guide to practical techniques for TQM" by Waller Jenny, Allen Derek and Burna Andrew (Kogan Page)

Solid Waste(OEC-11)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT I : Sources And Types Of Municipal Solid Wastes :Sources and types of solid wastes -

Quantity – factors affecting generation of solid wastes; characteristics – methods of sampling and characterization; Effects of improper disposal of solid wastes – public health effects. Principle of solid waste management – social & economic aspects; Public awareness; Role of NGOs; Legislation.

UNIT II : On-Site Storage & Processing :On-site storage methods – materials used for containers – on-site segregation of solid wastes – public health & economic aspects of storage – options under Indian conditions – Critical Evaluation of Options

UNIT III : Collection And Transfer :Methods of Collection – types of vehicles – Manpower requirement – collection routes; transfer stations – selection of location, operation & maintenance; options under Indian conditions.

UNIT IV : Off-Site Processing :Processing techniques and Equipment; Resource recovery from solid wastes – composting, incineration, Pyrolysis - options under Indian conditions.

UNIT V : DISPOSAL :Dumping of solid waste; sanitary land fills – site selection, design and operation of sanitary landfills – Leachate collection & treatment.

Text Books/Reference Books:

1. George Tchobanoglous et.al., "Integrated Solid Waste Management", McGraw-Hill Publishers, 1993.
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, "Waste Management", Springer, 1994
3. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000
4. R.E.Landreth and P.A.Rebers, "Municipal Solid Wastes – problems and Solutions", Lewis Publishers, 1997.
5. Bhide A.D. and Sundaresan, B.B., "Solid Waste Management in Developing Countries", INSDOC, 1993

Product Design and Development(OEC-12)	
No. of Credits: 3 L T P Total 3 0 0 3	 Total :100 Duration of Exams: 3 Hours

UNIT 1. Introduction: Design theory, design materials, human factors in design, man-machine system, applied ergonomics, characteristics of successful product development, challenges to product development.

UNIT 2.Development process and product planning: Generic development process, Concept development, product development process flows, product planning process, identify customer needs.

UNIT 3. Product specifications and concept generation:Product specification, steps to establish the target specifications, Concept generation, five step concept generation

method, concept selection, concept screening, concept testing, product architecture

UNIT 4. Product design methods:Creative and rational, clarifying objectives - the objective tree method, establishing functions- the function analysis method, setting requirements – the performance specification method, determining characteristics – the QFD method, generating alternatives – morphological chart method, evaluating alternatives – the weighted objective method, improving details – the value engineering method and design strategies.

UNIT 5. Design for manufacture: Estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment, design for graphics and packaging, effective prototyping – principle and planning

UNIT 6. Industrial design: Its need, impact and quality, industrial design process and its management, legal issues in product design, design resources, economics and management of product development projects.

UNIT 7. Prototyping: Basics and principles of prototyping, prototyping technologies, planning for prototypes

Text Books

1. K.T. Ulrich and S.D. Eppinger, "Product design and development", Tata McGraw Hill
2. Chitale & Gupta, "Product Development", Tata McGraw Hill
3. Monks, J. G., "Operations Management", McGraw Hill, 1997.
4. George Dietor, A material and Processing approach, McGraw Hill

Power Plant Engineering (OEC-13)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

UNIT 2. Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

UNIT 3. Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

UNIT 4. Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermodynamic efficiency of combined cycles. Problems.

UNIT 5. Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

UNIT 6. Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-out put curves, efficiency, heat rate, economic load sharing, Problems.

UNIT 7. Non-Conventional Power Generation: Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.

UNIT 8. Direct Energy Conversion Systems: Fuel cell, MHD power generation-principle, open & closed cycles systems, thermoelectric power generation, thermionic power generation.

Text Books

1. Power station Engineering and Economy by Bernhardt G.A. skrotzki and William A. Vopat – Tata Mc Graw Hill Publishing Campany Ltd., New Delhi
2. Power Plant Engineering: P.K. Nag Tata McGraw Hill second Edition 2001.

Robotics Engineering(OEC-14)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1 . Introduction: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Specifications of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies.

UNIT 2. Control of Robots:Concepts and Model about Basic Control System, Transformation and Block Diagram of Spring Mass System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Different Types of Controllers, Control Approaches of Robots.

UNIT3. . Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation.

UNIT4 . Robotic Workspace & Motion Trajectory: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance

Index, Extreme Reaches of Robotic Hands, Robotic Task Description.
UNIT5 . Robotic Motion Trajectory Design: Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:-4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.
UNIT6 .Industrial Applications: Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application, Challenges and Case Studies.

Text Books/ Reference Books:

1. A Robot Engineering Textbook – Mohsen Shahinpoor – Harper & Row publishers, New York.
2. Robotics, control vision and intelligence, Fu, Lee and Gonzalez. McGraw Hill International.
3. Introduction to Robotics, John J. Craig, Addison Wesley Publishing.
4. Robotics for Engineers , Yoram Koren, McGraw Hill International.
5. Industrial Robotics, Groover, Weiss, Nagel, McGraw Hill International.
6. Company Fundamentals of Robotics Analysis and Control, Schilling, PHI.
7. Introduction to Robotics, Niku, Pearson Education, Asia.
8. Robotics, control vision and intelligence, Fu, Lee and Gonzalez. McGraw Hill International.

icroprocessor and Interfacing(OEC-15)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT1. Architecture of 8085: Functional block diagram—Registers, ALU, Bus systems. Pin configuration, Timing and control signals, Machine cycle and timing diagrams. Interrupts—Types of interrupt, interrupt structure.

UNIT2. Programming of 8085: Instruction format, Addressing modes, Instruction set. Development of assembly language programs.

UNIT3. Interfacing Devices:(a).The 8255 PPI chip: Architecture, pin configuration, control words, modes and Interfacing with 8085. (b). The 8254 PIC chip: Architecture, pin configuration, control words, modes and Interfacing with 8085.

UNIT4. Interrupt and DMA controller: The 8259 Interrupt controller chip: Architecture, pin configuration, control words, modes

UNIT5. Architecture of 8086: Functional block diagram of 8086, details of sub-blocks such as EU, BIU,memory segmentation, physical address computations, pin configuration,

program relocation, Minimum and Maximum modes of 8086— Block diagrams and machine cycles.

UNIT6. Programming of 8086: Instruction format, Addressing modes, Instruction set and programs.

TEXT BOOKS:

1. Microprocessor Architecture, Programming & Applications with 8085: Ramesh S Gaonkar; Wiley Eastern Ltd.
2. Microprocessor and applications – A.K.Ray. , TMH

REFERENCE BOOKS:

1. Microprocessors and interfacing : Hall; TMH
2. The 8088 & 8086 Microprocessors-Programming, interfacing,Hardware& Applications :Triebel& Singh; PHI
3. Microcomputer systems: the 8086/8088 Family: architecture, Programming &Design : Yu-Chang Liu & Glenn A Gibson; PHI.
4. Advanced Microprocessors and Interfacing :Badri Ram; TMH

Digital Signal Processing(OEC-16)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT1. DISCRETE-TIME SIGNALS: Signal classifications, frequency domain representation, time domain representation, representation of sequences by Fourier transform, properties of Fourier transform, discrete time random signals, energy and power theorems.

UNIT2. DISCRETE-TIME SYSTEMS: Classification, properties, time invariant system, finite impulse Response (FIR) system, infinite impulse response (IIR) system.

UNIT3. SAMPLING OF TIME SIGNALS:Sampling theorem, application, frequency domain representation of sampling, reconstruction of band limited signal from its samples. Discrete time processing of continuous time signals, changing the sampling rate using discrete time processing.

UNIT4. Z-TRANSFORM: Introduction, properties of the region of convergence, properties of the Z-transform, inversion of the Z-transform, applications of Z-transform.

UNIT5. BASICS OF DIGITAL FILTERS: Fundamentals of digital filtering, various types of digital filters, design techniques of digital filters : window technique for FIR, bi-linear transformation and backward difference methods for IIR filter design, analysis of finite word length effects in DSP,FIR &IIR Filter structure-direct1,direct2,cascadeand parallel, Application of DSP

TEXT BOOKS :
1. Digital Signal Processing :Proakis and Manolakis; PHI
2. Digital Signal Processing: Salivahanan, Vallavaraj and Gnanapriya;TMH

REFERENCE BOOKS:
1. Digital Signal Processing: Alon V. Oppenhelm;PHI
2. Digital Signal processing(II-Edition): Mitra, TMH

Instrumentation and Control(OEC-17)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. OSCILLOSCOPE: Block diagram, study of various stages in brief, high frequency CRO considerations. Sampling and storage oscilloscope.

UNIT 2. ELECTRONIC INSTRUMENTS: Instruments for measurement of voltage, current & other circuit parameters, introduction to digital meters.

UNIT 3. GENERATION & ANALYSIS OF WAVEFORMS: Block diagram of pulse generators, signal generators, function generators wave analysers, distortion analysers, spectrum analyser, Harmonic analyser, introduction to power analyser.

UNIT 4. FREQUENCY & TIME MEASUREMENT: Study of decade counting Assembly(DCA), frequency measurements, period measurements, universal counter, introduction to digital meters.

UNIT 5. TRANSDUCERS: Classification, Transducers of types: RLC photocell, thermocouples etc. basic schemes of measurement of displacement, velocity, acceleration, strain, pressure, liquid level & temperature.

UNIT 6.CONTROL SYSTEM : Concept of transfer function, relationship between transfer function and impulse response, order of a system, block diagram algebra, signal flow graphs : Mason's gain formula & its application, characteristic equation, derivation of transfer functions of electrical and electromechanical systems. Transfer functions of cascaded and non-loading cascaded elements.

TEXT BOOK:

1. A course in Electrical & Electronics Measurements &Instrumentation :A.K.Sawhney; DhanpatRai& Sons.
2. Control System Engineering : I.J.Nagrath&M.Gopal; New Age
3. Modern Control Engg : K.Ogata; PHI.

REFERENCE BOOKS.

1. Electronics Instrumentation & Measurement Techniques : Cooper; PHI.

Data Communication and Networking(OEC-18)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT1. Introduction : Data Communication, Networks, Internet, Intranet, Protocols, OSI & TCP/IP Models Addressing. Physical Layer – Signals, Analog, Digital, Analog VS Digital, Transmission impairment, Data Rate Limits, Performance. Digital Transmission – Line Coding (Umipolar, Polar, Biphase), Block Coding (4B/5B Encoding), Analog to digital conversion, PCM, Transmission Modes. Analog Transmission – Digital to analog conversion (ASK, FSK, PSK, QAM), Analog to Analog conversion. Multiplexing – FDM, WDM, Synchronous TDM (time slots & frames, interleaving, data rate management). Spread Spectrum – FHSS, DSSS Transmission Media – Guided and Unguided. Switching – Switching, Circuit-Switched Networks, Datagram networks, Concept of Virtual circuit networks, structure of circuit and packet switch. Concepts of DSL and ADSL.

UNIT 2. Data Link Layer : Error correction & detection. Types of errors. Detection VS Correction, Block Coding, Hamming Distance, Linear Block codes (single parity check, hamming codes), Cyclic codes, CRC Encoder & Decoder, DRC Polynomial and its degree, Checksum.

UNIT 3.Network layer protocol : Internetworking,IPv4, IPv4 protocol packet format, IPv6 Protocol & Packet format, IPv4 VS IPv6, Transition from IPv4 to IPv6,Address Resolution protocols (ARP, RARP), BOOTP, DHCP, Routing Protocols – Delivery, forwarding, routing, types of routing, routing tables, Unicast Routing, Unicast Routing protocols, RIP, Concepts of OSPF, BGP & Multicast Routing Transport Layer – Process to process delivery, UCP, TCP Congestion Control & Quality of Service – Data traffic, Congestion, Congestion Control (Open Loop, Closed Loop & Congestion control in TCP), QoS and Flow Characteristics Application Layer – DNS, Remote Logging (Telnet), SMTP, FTP, WWW, HTTP

Soft Skills for Engineers (OEC-19)	
No. of Credits: 3 L T P Total 3 0 0 3	 Total :100 Duration of Exams: 3 Hours

Unit-I- CORPORATE INTERACTION, LEADERSHIP & COMMUNICATION

Part I.Audio/Video Lessons and Observation/Listening Skills (Practical)Interviews Lectures by Eminent Engineers, scientists and technocrats. Other inspiring speeches on social issues as well as related to the corporate world and industry.

Part-II.Group Discussions, Corporate Dialogue/Role Play (conflict and resolution);Mock-interviews.Discussions with briefs on CSR and IPR and role of important international bodies like WTO and IMF; Presentations; Technical/Business vocabulary; Body Language.

Part-III: Leadership & Participation:Review of social, political and corporate scene; Leadership skills, Attitudes, Sensitivity training.Learning/'Take-aways' from scenarios/situations. Crisis-handling; Negotiation-Conflict resolution exercises; Communication Skills; Seven Cs of Communication; Barriers of/to Effective Communication

Unit –II- CREATIVE COMPOSITION& TECHNICAL WRITING : Exercises in creative writing:USP and image building; Setting Goals; Charting Objectives; Minutes of a Meeting; Reports; Interoffice Memorandum; Resume and Covering Letter.

Unit –III- SEMANTICS &SYNTAX : Idioms & Proverbs, Vocabulary building, Crosswords, Neologisms, Portmanteau words, Correct sentences/usage.

Unit-IV- DISSERTATION & PRACTICAL ASSESSMENT :Short Multimedia Dissertation on any topic of student's interest; Group Discussion and Mock-interview .

Resources

- Stephen Robbins and Seema Sanghi.Organizational Behaviour. Pearson. Latest edition.
- Kotler, Philip and Kevin Lane Keller.Marketing Management. 13 th edition.2008 Eastern Economy Edition
- Wehmeier, Sally.*Oxford Advanced Learner's Dictionary*. Oxford UP.2005
- Ghosh, BN. Managing Soft Skills for Personality Development.Tata McGraw-Hill 2012
- Rizvi, M Ashraf. *Effective Technical Communication*. Tata Mc Graw-Hill.2005

- Bretag, Crossman and Bordia.Communication Skills. Tata Mc Graw-Hill.2009
- Sites: Youtube and Wikipedia in general.

Higher Engineering Mathematics(OEC-20)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT 1. Fourier transforms of integrals, Convolution theorem. application of fourier transform to solve standard equations/boundary value problems. Applications of fourier transform for solution of standard equations/boundary value problems.

UNIT2.Functions of Complex Variable : Definition, Exponential function, Trigonometric and Hyperbolic functions, Logarithmic functions, Limit and Continuity of a function, Differentiability and Analyticity. Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations. Harmonic functions,Milne Thomson Method to find harmonic conjugate of a function. application to flow problems. Integration of complex functions. Cauchy- Integral theorem and formula.Power series,radius and circle of convergence, Taylor's, Maclaurin's and Laurent's series.Zeroes and singularities of complex functions, Residues. Cauchy's residue theorem,Evaluation of real integrals using residues (around unit and semi circle only).

UNIT 3.Probability Distributions : Conditional probability, Bayes theorem and its applications, expected value of a random variable. Properties and application of Binomial, Poisson and Normal distributions.

Unit 4: Linear Programming: Linear programming problems formulation, solving linear programming problems using (i) Graphical method(corner point,iso cost/iso profit) (ii) Simplex method (iii) BIG M method (iv) Duality concept and Dual simplex method.

TEXT BOOKS :
1. Higher Engg. Mathematics : B.S. Grewal.
2. Advance Engg. Mathematics : R.K. Jain, S.R.K.Iyenger

REFERENCE BOOK
1. Advanced Engg. Mathematics : F Kreyszig.
2. Advanced Engg. Mathematics : Michael D. Greenberg.
3. Operation Research : H.A. Taha.
4. Probability and statistics for Engineers : Johnson. PHI

Human Resource Management(OEC-21)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT I : Human Resource Management: concept and scope; Roles, responsibilities and competencies of HR manager; Challenges to HR professionals; Human Resource Planning & Forecasting: significance and process.

UNIT II :HR Sourcing: Recruitment, Selection and Induction. Job Analysis: job Description and job Specification; Job Design: concept and methods; Job Evaluation-concept &methods; Performance appraisal and counselling.

UNIT III :Training: training process and methods; Career planning and Development; Succession planning; Employee Compensation: basic concepts & determinants;

UNIT IV: Industrial Relations and Grievance Handling; Employee welfare; Dispute Resolution; International Human Resource Management; Contemporary Issues in HRM. HR Audit &Accounting, ethics & corporate social responsibility.

Suggested Readings:

1. K. Aswathapa Human resource Management: Text and cases, 6th edition, Tata McGraw Hill, New Delhi,2012
2. Uday Kumar Haldar &Juthika Sarkar(2012) Human resource Management New Delhi, Oxford University Press.
3. De Cenvo, Da & Robbins S.P.(2010) Fundamentals of Human Resource Management, 9th edition, New York, John Wiley & Sons.
4. Gary Dessler (2008) Human Resource Management, 11th edition New Delhi: Pearson Prentice Hall.
5. Tanuja Agarwala, Strategic Human resource Management, Oxford University Press 2007.

Financial Management(OEC-22)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-I :Financial management-scope finance functions and its organisation, objectives of financial management; time value of money; sources of long term finance.

UNIT-II Investment decisions: importance, difficulties, determining cash flows, methods of capital budgeting; cost of different sources of raising capital; weighted average cost of capital.

UNIT-III:Capital structure: Meaning, importance, determinants and Theories. Financial and operating leverage; EBIT/EPS Analysis, determinants of dividend policy and dividend models -Walter, Gordon & M.M. models.

UNIT-IV:Working Capital- meaning, need, determinants; estimation of working capital need; management of cash, inventory and receivables.

Suggested Readings:

1. Pandey, I.M., Financial Management, Vikas Publishing House, New Delhi 10th edition 2010
2. Khan M.Y, and Jain P.K., Financial Management, Tata McGraw Hill, New Delhi
3. Keown, Arthur J., Martin, John D., Petty, J. William and Scott, David F, FinancialManagement, Pearson Education
4. Chandra, Prasanna, Financial Management, TMH, New Delhi
5. Van Horne, James C., Financial Management and Policy, Prentice Hall of India
6. Brigham & Houston, Fundamentals of Financial Management, Thomson Learning, Bombay.
7. Kishore, R., Financial Management, Taxman's Publishing House, New Delhi

Marketing Management(OEC-23)

No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-I:Nature and scope of marketing; Philosophies of marketing management; marketing environment; marketing research and marketing information system; Ethical issues in marketing

UNIT-II: Understanding consumer behaviour; factors influencing consumer buying behaviour and organizational buying behaviour; market segmentation, targeting and positioning; marketing strategies in the different stage of the product life cycle; new product development process

UNIT-III: Introduction to Product mix and product line decisions; branding and packaging decisions; Pricing strategies and practices; factors affecting selection of marketing channels; Introduction to wholesaling and retailing; Introduction to Promotion Mix: Advertising, sales promotion, public relations, personal selling

UNIT-IV :Sales Forecasting Methods; Introduction: Green Marketing; Event Marketing; Direct marketing; Network Marketing; Holistic Marketing; Permission Marketing; Social Marketing

Suggested Readings:
1. Kotler and Armstrong,Principles of Marketing; PHI, New Delhi
2. Kotler, Philip, Kevin Keller, A. Koshy and M. Jha, Marketing Management in South Asian Perspective , Pearson Education, New Delhi
3 . Kerin, Hartley, Berkowtz and Rudelius, Marketing, TMH, New Delhi
4. Etzel, Michael J, Marketing: Concepts and Cases, TMH, New Delhi
5. Kumar,Arun and Meenakshi,N. ,Marketing Management, Vikas Publication

Entrepreneur Development(OEC-24)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT I : Concept of Entrepreneur, Characteristics, qualities and pre-requisites of entrepreneur, entrepreneurship and intrapreneur, Entrepreneur vs. Manager; Economic, social and psychological need for entrepreneurship;

UNIT II :Environmental Factors affecting success of a new business, Formulation of business plan, Contents and significance of business plan

UNIT III: Feasibility Study -Preparation of Feasibility Reports: Economic, Technical, Financial and Managerial Feasibility of Project, Methods and procedures to start and expand one's own business

UNIT IV: Role of Government and Promotional agencies in entrepreneurship development, Entrepreneurship Development Programmes

Reference Books:

- Khanka S.S., “Entrepreneurship Development”. S.Chand.
- Desai, A N. "Entrepreneur & Environment". 1990. Ashish, New Delhi.

- Drucker, Peter. "Innovation and Entrepreneurship". 1985. Heinemann, London.
- Jain Rajiv. "Planning a Small Scale Industry: A Guide to Entrepreneurs". 1984. S.S. Books, Delhi.
- Kumar, S A. "Entrepreneurship in Small Industry". 1990, Discovery, New Delhi.
- McClelland, D C and Winter, W G. "Motivating Economic Achievement". 1969. Free Press, New York.
- Pareek, Udai and VenkateswaraRao, T. "Developing Entrepreneurship -A Handbook on Learning Systems". 1978, Learning Systems, Delhi.

Principal of Marketing and Management(OEC-25)	
No. of Credits: 3 L T P Total 3 0 0 3	Total :100 Duration of Exams: 3 Hours

UNIT-I :Introduction: concept, nature and significance of management; Functions of management, Levels of management and Managerial skills required at various levels, concept and process of human resource management, concept of marketing management and marketing mix, concept and major decisions of financial management.

UNIT-II: Process and types of planning, decision making process, basic issues in organizing types of organisation structure, delegation of authority and responsibility, departmentalisation, decentralization, span of management, line and staff relationship.

UNIT-III: Leadership styles/behaviours, leadership vs management; personal characteristics of effective leaders, theories of motivation; Maslow's Theory, Theory X and Y, Herzberg theory. management control – concept and process, managerial ethics and social responsibility

UNIT IV: Introduction to economics: micro vs macro economics. Relationship between science, engineering, technology and economic development. Meaning of Demand, Law of Demand, Elasticity of Demand. Law of Supply, Price equilibrium.

UNIT-V: Types of costs. Production function, Laws of production. Economies and diseconomies of scale. Market; types of market. Price equilibrium in perfect competition, monopoly, monopolistic competition, oligopoly.

OEC 26	Metro Systems and Engineering	3L:0T:0P	3 credits

GENERAL: Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financials

CIVIL ENGINEERING-Overview and construction methods for: Elevated and underground Stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings. Initial Surveys & Investigations; Basics of Construction Planning & Management, Construction Quality & Safety Systems. Traffic integration, multimodal transfers and pedestrian facilities; Environmental and social safeguards; Track systems-permanent way. Facilities Management

ELECTRONICS AND COMMUNICATION ENGINEERING- Signaling systems;

Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors.

MECHANICAL & TV + AC: Rolling stock, vehicle dynamics and structure; Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators

ELECTRICAL: OHE, Traction Power; Substations- TSS and ASS; Power SCADA; Standby and Back-up systems; Green buildings, Carbon credits and clear air mechanics.

AUDIT COURSES

MC CEFAE03:Environmental Sciences

MC CEFAE03: Environmental Science (Audit non-credit course)

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two type of activities.

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricitywaste
ii) Slogan makingevent
iii) Poster making event
iv) Cyclerally
v) Lectures from experts

(b) Actual Activities:

i) Plantation
ii) Gifting a tree to see its fullgrowth
iii) Cleanlinessdrive
iv) Drive for segregation of waste
v) To live some big environmentalist for a week or so to understand hiswork
vi) To work in kitchen garden formess
vii) To know about the different varieties ofplants
viii) Shutting down the fans and ACs of the campus for an hour orso

MC02: Constitution of India – Basic features and fundamental

principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom andAmerica.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate ourown

ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and itgradually made it "as one of the strongest court in theworld".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution ofIndia
3. Salient features and characteristics of the Constitution ofIndia
4. Scheme of the fundamentalrights
5. The scheme of the Fundamental Duties and its legalstatus
6. The Directive Principles of State Policy – Its importance andimplementation
7. Federal structure and distribution of legislative and financial powers between the Union and theStates
8. Parliamentary Form of Government in India – The constitution powers and status of the President ofIndia
9. Amendment of the Constitutional Powers andProcedure
10. The historical perspectives of the constitutional amendments inIndia
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right toEquality

14. Scheme of the Fundamental Right to certain Freedom under Article19
15. Scope of the Right to Life and Personal Liberty under Article21