MODEL CURRICULUM

for

UNDERGRADUATE DEGREE COURSES
IN

CIVIL ENGINEERING

(Engineering & Technology)

[January 2024]

Committee for Model Curriculum

S.No	Name	Designation & Organization
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3	**Dr. S.V. Dinesh,**	Professor, Principal SIT, Turnkur, Karnataka **(Member)**
4	**Dr. S. Shankar,**	Associate Professor, Department of Civil Engineering, National Institute of Technology Warangal **(Member)**
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6	**Dr. Ankit Guptha,**	Associate Professor, Department of Civil Engineering, Indian Institute of Technology (BHU), Varanasi **(Member)**
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All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology
CIVIL ENGINEERING
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All India Council for Technical Education Model

curriculum for

Undergraduate Degree Courses in Engineering & Technology CIVIL

ENGINEERING

Chapter -1

General, Course structure & Theme

Semester-wise credit distribution

A. **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	0.5 credits
2 Hours Practical (Lab) per week	1 credit

B. **Range of credits -**A range of credits from 160 to 164 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18 credits. These could be acquired through MOOCs.

C. **Structure of Undergraduate Engineering program:**

S. No.	Category	Breakup of Credits (Total 164)
1	Humanities and Social Sciences including Management courses	06
2	Basic Science Courses	24
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	20
4	Professional core courses	58

5	Professional Elective courses relevant to chosen specialization/branch	26
6	Indian Knowledge System	02
7	Multidisciplinary Open Electives Courses	12
8	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	16
9	Mandatory Non Credit Courses – Audit Course	(non-credit)
	Total	164*

Minor variation is allowed as per need of the respective disciplines.

D. Course Code and Definition:

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
PEC	Professional Elective Courses
MOPEC	Multidisciplinary Open Electives Courses
LC	Laboratory course
MNC- AU	Mandatory Non-Credit Courses – Audit Course
PR	Project
INT	Internship

E. Title of Courses	
E.01	**Humanities & Social Sciences including Management**
	HSMC 01: English for Technical Writing
	HSMC 02: Universal Human Value
E.02	**Basic Science Courses**
	BSC 01: Physics (Mechanics & Mechanics of Solids)
	BSC 02: Mathematics-I
	BSC 03: Chemistry -I
	BSC 04: Mathematics-II
	BSC 05: Biology for Engineers
	BSC 06: Mathematics for Civil Engineering
E.03	**Engineering Science Courses**
	ESC 01: Basic Electrical Engineering
	ESC 02: Engineering Graphics & Design
	ESC 03: Design Thinking
	ESC 04: Programming for Problem Solving
	ESC 05: Digital Fabrication/ Workshop / Manufacturing Practices
	ESC 06: Engineering Mechanics and Solid Mechanics
	ESC 07: Civil Engineering Materials, Testing & Evaluation
E.04	**Professional Core Courses/Fundamental Engineering Principles & Tools**
	PCC 01: Building Planning and Computer-aided Civil Engineering Drawing
	PCC 02: Concrete Technology
	PCC 03: Fluid Mechanics
	PCC 04: Transportation Engineering
	PCC 05: Surveying and Geomatics
	PCC 06: Geotechnical Engineering

	PCC 07: Hydraulic Engineering
	PCC 08: Structural Analysis
	PCC 09: Construction Engineering & Management
	PCC 10: Structural Design-I
	PCC 11: Environmental Engineering
	PCC 12: Engineering Economics, Estimation & Costing
	PCC 13: Hydrology & Water Resources Engineering
	PCC 14: Structural Design -II
	PCC 15 Intelligent Transportation Systems
	PCC 16: Sustainable and Green Construction
	PCC 17: Robotics and Automation in Civil Engineering
E.05	**Program Elective Courses**
	PEC 01: From Track
	PEC 02: From Track
	PEC 03: From Track
	PEC 04: From Track
	PEC 05: From Track
	PEC 06: From Track
	PEC 07: From Track
E.06	**Indian Knowledge System**
	IKS 01: From Basket
E.07	**Multidisciplinary Open Electives Courses**
	MOPEC 01: From Basket
	MOPEC 02: From Basket
	MOPEC 03: From Basket
	MOPEC 04: From Basket
E.08	**Internship (Six Months)**

E.09	**Project**
E.10	**Mandatory Non-Credit Audit Courses**
	MNC-AU 01: IDEA Lab Workshop
	MNC-AU 02: Sports and Yoga or NSS/NCC
	MNC-AU-03 Disability, Accessibility and Universal Design
	MNC -AU 04: Instrumentation & Sensor Technologies for Civil Engineering Applications
	MNC-AU 05: Civil Engineering – Societal & Global Impact
	MNC-AU 06: Professional Practice, Law & Ethics
	MNC-AU 07: Disaster Preparedness & Planning Management
E.11	**Minor/Honours/Value Added Courses (Optional)**
	MC/HC/VAC 01: From Track
	MC/HC/VAC 02: From Track
	MC/HC/VAC 03: From Track
	MC/HC/VAC 04: From Track
	MC/HC/VAC 05: From Track
	MC/HC/VAC 06: From Track

4-year Curriculum structure
Undergraduate Degree in Engineering & Technology

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

I. **Induction Program** (Please refer **Appendix-A** for guidelines. Details of Induction program also available in the curriculum of Mandatory courses.)

Induction program (mandatory)	3 weeks duration (Please refer Appendix-A for guidelines& also detailsavailable in the curriculum of Mandatory courses)
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

II.   Semester-wise structure of curriculum
[L= Lecture, T = Tutorials, P = Practicals & C = Credits]

Semester I (First year]

S. No.	Course Code	Course Title	L	T	P	Credit
3 WEEKS COMPULSORY INDUCTION PROGRAM (UHV-I)						
1	BS-01	Physics-I (Mechanics and Mechanics of Solids)	3	1	2	5
2	BS-02	Mathematics-I	3	1	0	4
3	ES-01	Basic Electrical Engineering	2	1	2	4
4	ES-02	Engineering Graphics & Design	1	0	4	3
5	HSM-01	English for Technical Writing	2	0	2	3
6	ES-03	Design Thinking	0	0	2	1
7	MNC-AU-01	IDEA Lab Workshop	2	0	4	0
TOTAL			**13**	**03**	**16**	**20**

Semester II (First year]

S. No.	Course Code	Course Title	L	T	P	Credit
1	BS-03	Chemistry -I	3	0	2	4
2	BS-04	Mathematics-II	3	1	0	4
3	ES-04	Programming for Problem Solving	2	0	4	4
4	BS-05	Biology for Engineers	3	0	0	3
5	ES-05	Digital Fabrication/ Workshop/Manufacturing Practices	0	0	4	2
6	HSM-02	Universal Human Values	2	1	0	3
7	MNC-AU-02	Sports and Yoga or NSS/NCC	2	0	4	0
		TOTAL	**15**	**02**	**14**	**20**

Semester III (Second year]

S. No.	Course Code	Course Title	Hours per week			Credits
			L	**T**	**P**	
1	ES -06	Solid Mechanics	3	0	2	4
2	BS-06	Mathematics to Civil Engineering -I	3	1	0	4
3	ES-07	Civil Engineering Materials, Testing & Evaluation	1	0	2	2
4	PCC - 01	Building Planning and Computer-aided Civil Engineering drawing	2	0	2	3
5	PCC- 02	Concrete Technology	2	0	2	3
6	PCC- 03	Fluid Mechanics	3	0	2	4
7	IKS	From Basket	2	0	0	2
8	MNC-AU-03	Disability, Accessibility and Universal Design	3	0	0	0
		Total	**19**	**01**	**10**	**22**
9		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

Semester IV (Second year]

S. No.	Couse Code	Course Title	Hours per week			Credits
			L	**T**	**P**	
1	PCC- 04	Transportation Engineering	2	0	2	3
2	PCC- 05	Surveying and Geomatics	3	0	2	4
3	PCC- 06	Geotechnical Engineering	3	0	2	4
4	PCC- 07	Hydraulic Engineering	3	0	2	4
5	PCC- 08	Structural Analysis	3	1	0	4
6	PCC- 09	Construction Engineering & Management	3	0	0	3
7	MNC-AU-04	Civil Engineering - Societal & Global Impact	3	0	0	0
		Total	**20**	**01**	**08**	**22**
8		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

Semester V (Third year]

S. No.	Course Code	Course Title	Hours per week			Credits
			L	**T**	**P**	
1	PCC- 10	Structural Design -I	3	0	2	4
2	PCC- 11	Environmental Engineering	3	0	2	4
3	PCC- 12	Engineering Economics, Estimation & Costing	3	0	2	4
4	PCC- 13	Hydrology & Water Resources Engineering	3	0	0	3
5	PEC- 01	Program Elective Course - 1	3	0	2	4
6	MOPEC- 01	Multidisciplinary Open Electives Courses -1	3	0	0	3
7	MNC- AU-05	Professional Practice, Law & Ethics	3	0	0	0
		Total	**21**	**00**	**08**	**22**
8		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

Semester VI (Third year]

S. No.	Course Code	Course Title	Hours per week			Credits
			L	**T**	**P**	
1	PCC- 14	Structural Design -II	3	0	2	4
2	PCC- 15	Intelligent Transportation Systems	3	0	0	3
3	PCC-16	Sustainable and Green construction	3	1	0	4
4	PEC- 02	Program Elective Course -2	3	0	2	4
5	PEC- 03	Program Elective Course -3	3	1	0	4
6	MOPEC - 02	Multidisciplinary Open Electives Courses -2	3	0	0	3
7	MNC-AU-06	Instrumentation & Sensor Technologies for Civil Engineering Applications	3	0	0	0
		Total	**21**	**01**	**04**	**22**
8		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

Semester VII (Fourth year]

S. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	PCC- 17	Robotics and Automation	2	0	0	2
2	PEC - 04	Program Elective Course - 4	3	0	0	3
3	MOPEC- 03	Multidisciplinary Open Electives Courses - 3	3	0	0	3
4	INT	Internship	0	0	24	12
5	MNC- AU- 07	Disaster Preparedness &Planning	3	0	0	0
		Total	**08**	**00**	**24**	**20**
6		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

Semester VIII (Fourth year]

S. No.	Code	Course Title	Hours per week			Credits
			L	T	P	
1	PEC- 05	Program Elective Course - 5	3	1	0	4
2	PEC- 06	Program Elective Course - 6	3	0	2	4
3	PEC- -07	Program Elective Course -7	3	0	0	3
4	MOPEC- 04	Multidisciplinary Open Electives Courses - 4	3	0	0	3
5	PR	Project	0	0	08	4
		Total	**12**	**01**	**14**	**20**
6		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

TOTAL CREDITS – 164

CHAPTER 2
TRACKS FOR PROGRAM ELECTIVES COURSES

Track	Program Elective Courses (PEC)
I	Structural Engineering
II	Construction Engineering & Management
III	Geotechnical Engineering
IV	Geo Informatics
V	Transportation Infrastructure
VI	Environmental Engineering
VII	Hydrology & Water Resources Engineering
VIII	Hydraulics
IX	Ocean Engineering
X	Diversified Courses

The suggestive list of Program Elective Courses (PEC)

I Structural Engineering

1. Structural Analysis-I &II

2. Advanced Structural Analysis

3. Structural Analysis by Matrix Methods

4. Structural Mechanics

5. Reliability Analysis of Structures

6. Engineering Risk & Uncertainty

7. Decision and Risk Analysis

8. Introduction to Finite Element analysis

9. Engineering Materials for Sustainability

10. Metal Structure Behavior- I &II

11. Masonry Structures

12. Reinforced Concrete

13. Advanced Concrete Technology

14. Design of Concrete Structures-I &II
15. Prestressed Concrete
16. Design of Steel Structures
17. Bridge Engineering, I & II
18. Industrial Structures
19. Design of Structural Systems
20. Structural Dynamics
21. Earthquake Engineering
22. Rehabilitation/Restoration of structures

II Construction Engineering & Management

1. Construction Productivity
2. Building Construction Practice
3. Formwork Engineering
4. Construction Cost Analysis
5. Sustainable Construction Methods
6. Construction Engineering Materials.
7. Contracts Management
8. Construction Equipment& Automation
9. Digitalized construction Lab
10. Construction Project Planning Systems.
11. Advanced Construction Techniques
12. Energy Efficient Buildings

III Geotechnical Engineering

1. Soil Mechanics-I & II
2. Foundation Engineering
3. Geotechnical Design
4. Structural Geology
5. Offshore Engineering
6. Rock Mechanics
7. Environmental Geo-technology

8. Ground Improvement Techniques

9. Soil Dynamics and Machine Foundation

10. Earth Retaining Structures

11. Tunnelling Engineering

IV Geo Informatics

1. Total station and GPS surveying

2. Remote sensing

3. Satellite Image Processing

4. Cartography and GIS

5. Photogrammetry

6. Airborne and Terrestrial laser mapping

7. Hydrographic surveying

V 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. Highway Construction and Management

11. Port and Harbor Engineering

12. High Speed Rail Engineering

13. Transportation Economics

14. Infrastructure Planning and Design

15. Smart Cities

VI Environment Engineering

1. Environmental Systems
2. Transport of Water and Wastewater
3. Environmental Laws and Policy
4. Physico-Chemical Processes for Water and Wastewater Treatment
5. Biological Processes for Contaminant Removal
6. Rural Water Supply and Onsite Sanitation Systems
7. Water and Air Quality Modelling
8. Solid and Hazardous Waste Management
9. Air and Noise Pollution Control Engineering
10. Environmental Impact Assessment and Life Cycle Analyses
11. Sustainable Engineering & Technology.
12. Climate change adaptation and Mitigation Participatory
13. Industrial Waste water Management
14. Environment Health and Safety
15. Ecological Engineering

VII Hydrology & Water Resources Engineering

1. Water Quality and Management
2. Surface Hydrology
3. Environmental Fluid Mechanics
4. Water Resources Field Methods
5. Water Resource Management
6. Groundwater Engineering
7. Watershed Conservation and Management
8. Urban water Infrastructure
9. Integrated water resource management

VIII Hydraulics

1. Design of hydraulic structures/Irrigation Engineering
2. Pipeline Engineering
3. 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

IX Ocean Engineering

1. Ocean Wave Dynamics
2. Marine Geotechnical Engineering
3. Coastal Engineering
4. Off Shore structures
5. Port Harbor Engineering
6. Coastal Hazards and Mitigation
7. Coastal Zone Management and Remote Sensing

X Diversified Course

1. Steel Concrete Composite structures
2. Finance for Engineering
3. Earth and Rockfill Dams
4. Computational Fluid Dynamics
5. Rainwater harvesting
6. Transport and environment
7. Environment Quality Monitoring.
8. Evaluating Accessibility / Universal Design in Built Environments

CHAPTER 3

DETAILED 4-YEAR CURRICULUM CONTENTS

Undergraduate Degree in Engineering & Technology

Branch/Course: CIVIL ENGINEERING

[Please note: The lab component of the course should have one hour of tutorial followed or preceded by laboratory assignments wherever required.]

SEMESTER -I

BSC 01	Physics (Introduction to Mechanics)	3L:1T:2P	5 credits

Module I

Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates.

Module II

Potential energy function; $F = -$ Grad V, equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Kepler problem; Application: Satellite manoeuvres;

Module III

Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula. Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum;

Module IV

Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance.

Module V

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

Module V

Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.

Laboratory - Introduction to Mechanics

1. Suggested list of experiments from the following:
2. Coupled oscillators;
3. Experiments on an air-track;
4. Experiment on moment of inertia measurement,

5. Experiments with gyroscope;

6. Resonance phenomena in mechanical oscillators.

TEXTBOOKS/REFERENCES:

1. Engineering Mechanics, 2nd ed. — MK Harbola

2. Introduction to Mechanics — MK Verma

3. An Introduction to Mechanics — D Kleppner & R Kolenkow

4. Principles of Mechanics — JL Synge & BA Griffiths

5. Mechanics — JP Den Hartog

6. Engineering Mechanics - Dynamics, 7th ed. - JL Meriam

7. Mechanical Vibrations — JP Den Hartog

8. Theory of Vibrations with Applications — WT Thomson

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING MECHANICS	PROF. MANOJ HARBOLA	IIT KANPUR

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Experiment on moment of inertia measurement.	https://vlab.amrita.edu/?sub=1&brch=74&sim=571&cnt=1

| BSC 02 | Mathematics- I | 3L: 1 T: 0P | 4 Credits |

Course Objectives: The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Contents:

Module 1: Basic Calculus: (6 hours)
Curvature, evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Single-variable Calculus (Differentiation): (6 hours)
Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.

Module 3: Sequences and series: (10 hours)
Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.

Module 4: Multivariable Calculus (Differentiation): (8 hours)
Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 5: **Multivariable Calculus (Integration):** (10 hours)
Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-I (Calculus & Linear Algebra), Khanna Book Publishing Co.

2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.

3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.

4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:

(1) Module 1: The relevant sections from Chapters 2, 6 and 11 of [3].

(2) Module 2: Sections 3.1, 3.2, 3.3, 3.7 & 6.6 of [1].

(3) Module 3: Sections 8.1-8.6, 8.8-8.10 of [1].

(4) Module 4: Sections 12.1-12.5, 12.7-12.9 of [1].

(1) Module 5: Sections 13.1 – 13.7, 14.1 – 14.8 of [1].

Course outcomes: The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate differentiation and integration. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.

- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- The tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

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ESC 01	Basic Electrical Engineering	2L: 1 T: 2P	4 Credits

Course Objective: The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Course Contents:

Module I: D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Module II: Single Phase A.C. Circuits covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Module III: Transformers covering, Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

Module IV: DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Module V: Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Module VI: Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;

TEXT/REFERENCS BOOKS:

1. AICTE's Prescribed Textbook: Basic Electrical Engineering, Khanna Book Publishing.
2. Ritu Sahdev (2022), Basic Electrical Engineering, Khanna Book Publishing.
3. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
5. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
6. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India Hughes, E. 2005)

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	BASIC ELECTRIC CIRCUITS	PROF. ANKUSH SHARMA	IIT KANPUR
2	BASIC ELECTRICAL CIRCUITS	PROF. NAGENDRA KRISHNAPURA	IITM
3	FUNDAMENTALS OF ELECTRICAL ENGINEERING	PROF. DEBAPRIYA DAS	IIT KGP

COURSE OUTCOMES:

The students will learn:

1. To explain strong basics of Electrical Engineering and practical implementation of Electrical fundamentals.
2. To identify different applications of commonly used electrical machinery.

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ESC 02	**Engineering Graphics & Design**	**1L: 0 T: 4P**	**3 Credits**

COURSE OBJECTIVE(S):

The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

COURSE CONTENTS:

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

Module I: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module II: Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module III: Projections of Regular Solids

Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module IV: Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

Module V: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Module VI: Overview of Computer Graphics

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module VII: Customisation & CAD Drawing

Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module VIII: Annotations, layering & other functions

Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section

views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module IX: Demonstration of a simple team design project that illustrates

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. AICTE's Prescribed Textbook: Engineering Graphics & Design Khanna Book Publishing.
2. Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
3. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
5. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
7. (Corresponding set of) CAD Software Theory and User Manuals.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	PROF. RAJARAM LAKKARAJU	IIT KGP	ENGINEERING DRAWING AND COMPUTER GRAPHICS
2	PROF. NIHAR RANJAN PATRA	IIT KANPUR	ENGINEERING GRAPHICS

Course Outcomes:

All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

● to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
● to prepare you to communicate effectively
● to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The students will learn:
● To describe engineering design and its place in society.
● To discuss the visual aspects of engineering design.
● To use engineering graphics standards.
● To illustrate solid modelling.
● To use computer-aided geometric design.
● To design creating working drawings.
● To inspect engineering communication.

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HSM-01	**English for Technical Writing**	2L: 0 T: 2P	**3 Credits**

Course Objective:

- To provide learning environment to practice listening, speaking, reading and writing skills.
- To assist the students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

Course Content:

Module I: Vocabulary Building

1.1. The concept of Word Formation

1.2. Root words from foreign languages and their use in English

1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.

1.4. Synonyms, antonyms, and standard abbreviations.

Module II: Basic Writing Skills

1.1. Sentence Structures

1.2. Use of phrases and clauses in sentences

1.3. Importance of proper punctuation

1.4. Creating coherence

1.5. Organizing principles of paragraphs in documents

1.6. Techniques for writing precisely

Module III: Identifying Common Errors in Writing

1.1. Subject-verb agreement

1.2. Noun-pronoun agreement

1.3. Misplaced modifiers

1.4. Articles

1.5. Prepositions

1.6. Redundancies

1.7. Clichés

Module IV: Nature and Style of sensible Writing

1.1. Describing

1.2. Defining

1.3. Classifying

1.4. Providing examples or evidence

1.5. Writing introduction and conclusion

Module V: Writing Practices

1.1. Comprehension

1.2. Précis Writing

1.3. Essay Writing

Module VI: Oral Communication

(This Module involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Text/Reference Books:

1. AICTE's Prescribed Textbook: English (with Lab Manual), Khanna Book Publishing Co.
2. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Remedial English Grammar. F.T. Wood. Macmillan.2007
5. On Writing Well. William Zinsser. Harper Resource Book. 2001
6. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
7. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGLISH LANGUAGE FOR COMPETITIVE EXAMS	PROF. AYSHA IQBAL	IIT MADRAS
2.	TECHNICAL ENGLISH FOR ENGINEERS	PROF. AYSHA IQBAL	IITM

Course Outcomes: The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

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ESC-03	Design Thinking	0L: 0 T: 2P	1 Credit

COURSE OBJECTIVE(S):

The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

COURSE CONTENTS:

Unit 1: An Insight to Learning

Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Unit 2: Remembering Memory

Understanding the Memory process, Problems in retention, Memory enhancement techniques

Unit 3: Emotions: Experience & Expression

Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers

Unit 4: Basics of Design Thinking

Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – **Empathize, Define, Ideate, Prototype, Test**

Unit 5: Being Ingenious & Fixing Problem

Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving

Unit 6: Process of Product Design

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, **Assignment – Engineering Product Design**

Unit 7: Prototyping & Testing

What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, **Sample Example**, Test Group Marketing

Unit 8: Celebrating the Difference

Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

Unit 9: Design Thinking & Customer Centricity

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Unit 10: Feedback, Re-Design & Re-Create

Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – **"Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".**

Course Outcomes (CO):

Student will able to

1. Compare and classify the various learning styles and memory techniques and Apply them in their engineering education

2. Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products

3. Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products

4. Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development

5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

Text/Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.

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MNC AU-01	IDEA Lab Workshop	2L: 0 T: 4P	0 Credits

Course Objectives:

1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
2. Learn useful mechanical and electronic fabrication processes.
3. Learn necessary skills to build useful and standalone system/ project with enclosures.
4. Learn necessary skills to create print and electronic documentation for the system/project

Course Contents:

Unit #	Topics	
1	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,
2	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.

	multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4.	Discussion and implementation of a mini project.	
5.	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.

4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

S. No.	Title
1.	AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing.
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6.	The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978-1681881584.
7.	Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374

8.	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9.	Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10.	Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11.	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12.	Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13.	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13 : 978-1260019193.
14.	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15.	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer.
16.	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17.	Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

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SEMESTER -II

BSC-03	Chemistry- I	3L: 0 T: 2P	4 Credits

Course Objective:

The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Course Content:

Module I: Atomic and Molecular Structure

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Module II: Spectroscopic techniques and applications

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Module III: Intermolecular forces and potential energy surfaces

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module IV: Use of free energy in chemical equilibria (6 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Module V: Periodic properties

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Module VI: Stereochemistry

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

Module VII: Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

LABORATORY

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual, Khanna Book Publishing.

2. Engineering Chemistry, by Manisha Agrawal.

3. University chemistry, by B. H. Mahan

4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane

5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell

6. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

7. Physical Chemistry, by P. W. Atkins

8. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition
   http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	CHEMISTRY - I	PROF. MANGALA SUNDER KRISHNAN	IITM

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-

		of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/
5	Determination of the rate constant of a reaction.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
6	Determination of cell constant and conductance of solutions.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/
7	Potentiometry - determination of redox potentials and emfs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/
9	Lattice structures and packing of spheres.	https://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Course Outcomes: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometre levels, one has to base the description of all chemical processes at molecular levels. The course will enable the students:

● To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
● To rationalise bulk properties and processes using thermodynamic considerations.
● To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
● To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
● To list major chemical reactions that are used in the synthesis of molecules.

Laboratory Outcomes: The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn:

- To estimate rate constants of reactions from concentration of reactants/products as a function of time.
- To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
- To synthesize a small drug molecule and analyze a salt sample.

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BSC-04	Mathematics- II	3L: 1 T: 0P	4 Credits

Course Objective: Mathematics fundamental necessary to formulate, solve and analyze engineering problems.

Course Content:

Module 1: Matrices (10 hours)

Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Module 2: First order ordinary differential equations: (6 hours)

Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (8 hours)

Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (8 hours):

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration: (8 hours):

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co.
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.

3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.

4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.

5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.

7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.

11. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

12. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

13. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:

(1) Module 1: Sections 7.3-7.5, 7.7, 7.8, 8.1-8.4 of [1].

(2) Module 2: Sections 1.4, 1.5 of [1]; Section 5.1 of [2].

(3) Module 3: Sections 2.5, 2.6, 2.10, 5.1, 5.3, 5.4, 5.5 of [1].

(4) Module 4: Sections 13.3 – 13.7, 17.1 – 17.3 of [1].

(5) Module 5: Sections 14.1 – 14.4, 15.2 – 15.4, 16.1 – 16.4 of [1].

COURSE OUTCOMES: The objective of this course is to familiarize the prospective engineers with techniques in matrices, ordinary differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The essential tool of matrices and linear algebra in a comprehensive manner.

- The effective mathematical tools for the solutions of differential equations that model physical processes.

- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

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ESC-04	**Programming for Problem Solving**	2L: 0 T: 4P	4 Credits

Course Objectives:

1. To learn the fundamentals of computers.

2. To understand the various steps in program development.

3. To learn the syntax and semantics of C programming language.

4. To learn the usage of structured programming approach in solving problems.

5. To understated and formulate algorithm for programming script

6. To analyze the output based on the given input variables

Course Contents:

Module I: Introduction to Programming**;** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Module II: Arithmetic expressions and precedence.

Module III: Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Module IV: Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Module V: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module VI: Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Module VII: Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module VIII: Structures, Defining structures and Array of Structures

Module IX: Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Module X: File handling (only if time is available, otherwise should be done as part of the lab).

PRACTICALS:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

TEXT/REFERENCE BOOKS:

1. AICTE's Prescribed Textbook: Programming for Problem Solving, Khanna Book Publishing Co.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO PROGRAMMING IN C	PROF. SATYADEV NANDAKUMAR	IITK
2	PROBLEM SOLVING THROUGH PROGRAMMING IN C	PROF. ANUPAM BASU	IIT KGP

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?do main=Computer%20Science&lab=Proble m%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?do main=Computer%20Science&lab=Proble m%20Solving%20Lab
3	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?do main=Computer%20Science&lab=Proble m%20Solving%20Lab
5	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?do main=Computer%20Science&lab=Proble m%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?do main=Computer%20Science&lab=Proble m%20Solving%20Lab

COURSE OUTCOMES: The student will learn following through lectures:

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

The student will learn following through Practicals:

- To formulate the algorithms for simple problems.
- To translate given algorithms to a working and correct program.
- To be able to correct syntax errors as reported by the compilers.
- To be able to identify and correct logical errors encountered at run time.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.
- To be able to declare pointers of different types and use them in defining self-referential structures.
- To be able to create, read and write to and from simple text files.

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BSC-05	**Biology (Biology for Engineers)**	**3L:0T:0P**	**3 Credits**

Module 1. 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 18th 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. 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 -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.-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. 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 catalyze reactions. 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. 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. DICOM Image formats, The DNA Technology (Use and Application) Regulation Bill, 2019

Module 7. 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.- 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 Keq 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. 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) General Biology, Uma Devi Koduru, Khanna Book Publishing Company.

2) 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

3) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons

4) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company

5) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher

6) 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
- Apply thermodynamic principles to biological systems.
- Identify and classify microorganisms

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ESC- 05	Digital Fabrication	0L:0T:4P	2 Credits

Course Objective:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Content:

1. 3D Printing (Additive Manufacturing)

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. CAD for Additive Manufacturing

CAD Data formats, Data translation, Data loss, STL format.

3. Additive Manufacturing Techniques

3.1 Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

3.2 Process, Process parameter, Process Selection for various applications.

3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. **Materials**

4.1 Polymers, Metals, Non-Metals, Ceramics

4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation

and their desired properties, Polymers and their properties.

4.3 Support Materials

5. **Additive Manufacturing Equipment**

5.1 Process Equipment- Design and process parameters

5.2 Governing Bonding Mechanism

5.3 Common faults and troubleshooting

5.4 Process Design

6. **Post Processing: Requirement and Techniques**

7. **Product Quality**

      7.1 Inspection and testing

      7.2 Defects and their causes

LIST OF PRACTICALS

1. 3D Modelling of a single component

2. Assembly of CAD modelled Components

3. Exercise on CAD Data Exchange.

4. Generation of .stl files.

5. Identification of a product for Additive Manufacturing and its AM process plan.

6. Printing of identified product on an available AM machine.

7. Post processing of additively manufactured product.

8. Inspection and defect analysis of the additively manufactured product.

9. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing Co.

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies:

   Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid

   Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.

5. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.

6. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in

   Material Science, 2013.

7. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.

8. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM)

Processes of Titanium Alloy", InTech, 2012.

Course Outcomes: After completion of this course, the students will be able to:

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate. stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

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ESC- 05	Workshop/Manufacturing Practices	0L:0T:4P	2 Credits

Course Objective:

1. To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

2. To have a study and hands-on-exercise on plumbing and carpentry components.

3. To have a practice on gas welding, foundry operations and fitting

4. To have a study on measurement of electrical quantities, energy and resistance to earth.

5. To have a practice on soldering.

Course Content:

Module I: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.

Module II: CNC machining, Additive manufacturing.

Module III: Fitting operations & power tools.

Module IV: Electrical & Electronics.

Module V: Carpentry.

Module VI: Plastic moulding, glass cutting.

Module VII: Metal casting.

Module VIII: Welding (arc welding & gas welding), brazing.

Practicals:

1. Machine shop

2. Fitting shop

3. Carpentry

4. Electrical & Electronics

5. Welding shop (Arc welding + Gas welding)

6. Casting

7. Smithy

8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai**.**

2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Welding shop (Arc welding + Gas welding).	http://mm- coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2	Casting	http://fab- coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

Course Outcomes: Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Laboratory Outcomes:

Upon completion of this laboratory course, students will be able:

● To fabricate components with their own hands.

● To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.

● To design small devices of their interest by assembling different components

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HSM - 02	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2L:1T:0P	3 Credits

Pre-requisites: None. Universal Human Values 1 (Desirable)

1- COURSES ON HUMAN VALUES

During the Induction Program, students would get an initial exposure to human values through Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course.

Objectives of UHV-II Course

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.

2. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Salient Features of the Course

The salient features of this course are:

1. It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.

2. The whole course is presented in the form of a dialogue whereby a set of proposals

about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.

3. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.

4. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.

2. The course is in the form of 28 lectures (discussions) and 14 practice sessions.

3. It is free from any dogma or value prescriptions.

4. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.

5. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.

6. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

2- COURSE TOPICS

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 01-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

The syllabus for the lectures and practice sessions is given below:

Module 1 – Introduction to Value Education (6 lectures and 3 tutorials for practice session)

> **Lecture 1:** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
>
> **Lecture 2:** Understanding Value Education
>
> **Tutorial 1**: **Practice Session PS1**   Sharing about Oneself
>
> **Lecture 3:** Self-exploration as the Process for Value Education
>
> **Lecture 4:** Continuous Happiness and Prosperity – the Basic Human Aspirations
>
> **Tutorial 2: Practice Session PS2**   Exploring Human Consciousness
>
> **Lecture 5:** Happiness and Prosperity – Current Scenario
>
> **Lecture 6:** Method to Fulfill the Basic Human Aspirations
>
> **Tutorial 3: Practice Session PS3**   Exploring Natural Acceptance

Expected outcome:

The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.

The students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of most of the present-day problems; and a sustained solution could emerge only through understanding of value-based living. Any solution brought out through fear, temptation of dogma will not be sustainable.

The students are able to see that verification on the basic of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.

The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to

overcome this disharmony.

The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facility in most of the cases, while they have given higher priority to earning of physical facility in their life giving less value to or even ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

    Lecture 7: Understanding Human being as the Co-existence of the Self and the Body

    Lecture 8: Distinguishing between the Needs of the Self and the Body

    Tutorial 4: Practice Session PS4   Exploring the difference of Needs of Self and Body

    Lecture 9: The Body as an Instrument of the Self

    Lecture 10: Understanding Harmony in the Self

    Tutorial 5: Practice Session PS5   Exploring Sources of Imagination in the Self

    Lecture 11: Harmony of the Self with the Body

    Lecture 12: Programme to ensure self-regulation and Health

    Tutorial 6: Practice Session PS6   Exploring Harmony of Self with the Body

Expected outcome:

The students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and Body are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.

The students are able to see that all physical facility they are required for a limited time in a limited quantity. Also, they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.

The students are able to see that activities like understanding, desire, though and selection are the activities of 'I' only the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with

their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.

The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance

The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

Module 3 – Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

      Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

      Lecture 14: 'Trust' – the Foundational Value in Relationship

      Tutorial 7: Practice Session PS7   Exploring the Feeling of Trust

      Lecture 15: 'Respect' – as the Right Evaluation

      Tutorial 8: Practice Session PS8   Exploring the Feeling of Respect

      Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

      Lecture 17: Understanding Harmony in the Society

      Lecture 18: Vision for the Universal Human Order

      Tutorial 9: Practice Session PS9   Exploring Systems to fulfil Human Goal

Expected outcome:

The students are able to note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life

for them and for others through he may have different body, physical facility or beliefs.

The students are able to use their creativity for education children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

Module 4 – Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

Expected outcome:

The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human being s are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.

The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also, they are able to make out how these courses can be made appropriate and holistic.

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Expected outcome:

The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.

The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.

The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for the happy and prosperous family and society.

Guidelines and Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1   Sharing about Oneself

PS2   Exploring Human Consciousness

PS3   Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being

PS4   Exploring the difference of Needs of Self and Body

PS5   Exploring Sources of Imagination in the Self

PS6   Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society

PS7   Exploring the Feeling of Trust

PS8   Exploring the Feeling of Respect

PS9   Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

PS10   Exploring the Four Orders of Nature

PS11   Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12   Exploring Ethical Human Conduct

PS13   Exploring Humanistic Models in Education

PS14   Exploring Steps of Transition towards Universal Human Order

As an example, PS 7 is a practice session in module 3 regarding trust. It is explained below:

PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?	1b. Am I able to make myself always happy?
2a. Do I want to make the other happy?	2b. Am I able to make the other always happy?
3a. Does the other want to make him happy?	3b. Is the other able to make him always happy?
4a. Does the other want to make me happy?	4b. Is the other able to make me always happy?
Intention (Natural Acceptance) What is the answer?	Competence What is the answer?

Let each student answer the questions for himself/herself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention and competence as well as the others' intention and competence.

Expected outcome of PS 7: The students are able to see that the first four questions are related to our Natural Acceptance i.e. intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention, as a result we conclude that I am a good person and other is a bad person.

3- READINGS:

3-1-Text Book and Teachers Manual

a. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53

c. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

3-2-Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.

2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

3. The Story of Stuff (Book).

4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi

5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews

7. Economy of Permanence - J C Kumarappa

8. Bharat Mein Angreji Raj – Pandit Sunderlal

9. Rediscovering India - by Dharampal

10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

11. India Wins Freedom - Maulana Abdul Kalam Azad

12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)

4- MODE OF CONDUCT (L-T-P-C 2-1-0-3)

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

5- SUGGESTED ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

6- OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

This is only an introductory foundational input. It would be desirable to follow it up by

a) Faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living.

MNC AU-02	Sports and Yoga	1L:0T:4P	0 Credits

Course Objective(s):

● To make the students understand the importance of sound health and fitness principles as they relate to better health.

● To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.

● To create a safe, progressive, methodical and efficient activity-based plan to enhance improvement and minimize risk of injury.

● To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

Module I: Introduction to Physical Education

o Meaning & definition of Physical Education

o Aims & Objectives of Physical Education

o Changing trends in Physical Education

Module II: Olympic Movement

o Ancient & Modern Olympics (Summer & Winter)

o Olympic Symbols, Ideals, Objectives & Values

o Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

Module III: Physical Fitness, Wellness & Lifestyle

o Meaning & Importance of Physical Fitness & Wellness

o Components of Physical fitness

o Components of Health related fitness

o Components of wellness

o Preventing Health Threats through Lifestyle Change

o Concept of Positive Lifestyle

Module IV: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga

- Define Anatomy, Physiology & Its Importance
- Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

Module V: Kinesiology, Biomechanics & Sports

- Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
- Newton's Law of Motion & its application in sports.
- Friction and its effects in Sports.

Module VI: Postures

- Meaning and Concept of Postures.
- Causes of Bad Posture.
- Advantages & disadvantages of weight training.
- Concept & advantages of Correct Posture.
- Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
- Corrective Measures for Postural Deformities

Module VII: Yoga

- Meaning & Importance of Yoga
- Elements of Yoga
- Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
- Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)
- Relaxation Techniques for improving concentration - Yog-nidra

Module VIII: Yoga & Lifestyle

- Asanas as preventive measures.
- Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.
- Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana,

Trikonasana, Ardh Matsyendrasana.

o Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.

o Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.

o Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

Module IX: Training and Planning in Sports

o Meaning of Training

o Warming up and limbering down

o Skill, Technique & Style

o Meaning and Objectives of Planning.

o Tournament – Knock-Out, League/Round Robin & Combination.

Module X: Psychology & Sports

o Definition & Importance of Psychology in Physical Edu. & Sports

o Define & Differentiate Between Growth & Development

o Adolescent Problems & Their Management

o Emotion: Concept, Type & Controlling of emotions

o Meaning, Concept & Types of Aggressions in Sports.

o Psychological benefits of exercise.

o Anxiety & Fear and its effects on Sports Performance.

o Motivation, its type & techniques.

o Understanding Stress & Coping Strategies.

Module XI: Doping

o Meaning and Concept of Doping

o Prohibited Substances & Methods

o Side Effects of Prohibited Substances

Module XII: Sports Medicine

o First Aid – Definition, Aims & Objectives.

o Sports injuries: Classification, Causes & Prevention.

o Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Module XIII: Sports / Games

Following subtopics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

- o   History of the Game/Sport.

- o   Latest General Rules of the Game/Sport.

- o   Specifications of Play Fields and Related Sports Equipment.

- o   Important Tournaments and Venues.

- o   Sports Personalities.

- o   Proper Sports Gear and its Importance.

Text Books/References:

1.   Modern Trends and Physical Education by Prof. Ajmer Singh.
2.   Light On Yoga By B.K.S. Iyengar.
3.   Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes: On successful completion of the course the students will be able:

1.   To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.
2.   To learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
3.   To learn breathing exercises and healthy fitness activities
4.   To understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.
5.   To perform yoga movements in various combination and forms.
6.   To assess current personal fitness levels.
7.   To identify opportModuleies for participation in yoga and sports activities.
8.   To develop understanding of health-related fitness components: cardiorespiratory endurance, flexibility and body composition etc.
9.   To improve personal fitness through participation in sports and yogic activities.
10. To develop understanding of psychological problems associated with the age and lifestyle.

11. To demonstrate an understanding of sound nutritional practices as related to health and physical performance.

12. To assess yoga activities in terms of fitness value.

13. To identify and apply injury prevention principles related to yoga and physical fitness activities.

14. To understand and correctly apply biomechanical and physiological principles elated to exercise and training.

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SEMESTER -III

ESC06	**Mechanics of Solids**	3L:0T:2P	4 credits

Prerequisites: (i) Physics 1, both modules

(ii) Mathematics course with ordinary diff*erential equations*

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.

List of Experiments:
- Tension test
- Bending tests on simply supported beam and Cantilever beam.
- Compression test on concrete
- Impact test
- Shear test
- Investigation of Hook's law that is the proportional relation between force and stretching in elastic deformation,
- Determination of torsion and deflection,
- Measurement of forces on supports in statically determinate beam,

➢ Determination of shear forces in beams,

➢ Determination of bending moments in beams,

➢ Measurement of deflections in statically determinate beam,

➢ Measurement of strain in a bar

➢ Bend test steel bar;

➢ Yield/tensile strength of steel bar;

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;

BSC06	Mathematics to Civil Engineering	3L:1T:0P	4 credits

Prerequisites: (i) Physics

(ii) Mathematics I and II

Course Outcomes:

After completion of course students will be able to:

1. Determine, and apply, the important quantities associated with scalar fields and vector fields, such as the gradient vector, directional derivative, the divergence, curl and evaluate line, surface, and volume integrals to verify the seminal integral theorems (Green's theorem in the plane, Gauss' divergence theorem and Stokes' theorem).

2. Use basic knowledge of Fourier series and develop Fourier series of periodic functions.

3. Demonstrate the ability to evaluate Laplace as well as Inverse Laplace Transform of function and solve the ordinary differential equations and linear time invariant systems.

4. Introduction to partial differential equations (PDEs) and their applications to engineering sciences.

5. Demonstrate knowledge of Matrix calculations as an elegant and powerful mathematical language in connection with Eigen value and Eigen vector, Diagonalization.

1. BASIC CONCEPTS OF VECTOR CALCULUS

1.1 Scalar and vector point function, differential operator, gradient, directional derivative, physical meaning of gradient, divergence, curl and Laplacian with their properties

1.2 Line Integrals, Surface Integral, Volume integral

1.3 Green's theorem, Gauss' theorem and Stoke's theorem & its application.

2. FOURIER SERIES

2.1 Definition of Fourier series, Orthogonal and orthonormal functions

2.2 Fourier series with arbitrary period, in particular periodic function with period 2π

2.3 Fourier series of even and odd function

2.4 Half range Fourier series.

3. LAPLACE TRANSFORMS AND APPLICATIONS:

3.1 Introduction, Definition of the Laplace transform,

3.2 Useful properties of Laplace transform (without proof): Linearity, Frist shifting theorem, Multiplication and division by t, transforms of derivatives and integrals, Heaviside unit step function, Dirac's delta function, second shifting theorem, Laplace transform of Periodic function

3.3 Inverse Laplace transform using partial fraction and Convolution theorem (without proof)

3.4 Application to solve initial and boundary value problem involving ordinary differential equations with one dependent and constant coefficient.

4. PARTIAL DIFFERENTIAL EQUATION

4.1 Second order PDE of mathematical physics (Heat, wave and Laplace equation, one dimensional with standard boundary conditions)

4.2 Solution by separation of variable method using Fourier series.

5. MATRICES

5.1 Eigen values Eigen vectors of square matrix

5.2 Cayley Hamilton's theorem and function of square matrix

5.3 Diagonalization of square matrix

5.4 Minimal Polynomial and Minimal Equation of a Matrix

5.5 Derogatory and Non-Derogatory Matrices

Recommended Reading:

1) Kreyszing E., "Advanced Engineering Mathematics", John Wiley & Sons, Singapore, Int.Student Ed. 1995. (ISBN 8126554231)

2) Wiley C. R., "Advanced Engineering Mathematics", McGraw Hill Inc., New York Ed.1993.

3) O'Neel Peter., "Advanced Engg. Mathematics", Thompson, Singapore, Ind. Ed. 2002.

4) Greenbar Michael D., "Advanced Engg. Mathematics", Pearson, Singapore, Ind. Ed.

5) Ramana D. V., "Higher Engg. Mathematics", The MaGraw-Hill Inc., New Delhi, 2007. (ISBN 007063419X)

6) Marsden J. E., Tromba A., Weinstein A., "Basic multivariable calculus", Springer, 1993. (ISBN 354097976X)

7) A. R. Vasishtha, A. K. Vasishtha, "Matrices", Krishna Prakashan Media, 1991. (ISBN 8182837294)

ESC07	Civil Engineering, Materials, Testing and Evaluation	3L:1T:0P	4 credits

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 andnonferrous 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.

Practical's:

- ➢ 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

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)
7. Related papers published in international journals

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-01	Building Planning and Computer Aided Civil Engineering Drawings	2L:0T:2P	4 credits

Course Outcomes

After completion of course, students will be able to

1. Implement principles of planning of buildings

2. Design and draw various constructional drawing of the buildings.

3. Plan various building services.

Course Contents:

1. **Principles of Residential and Public Buildings:**

   Concept of built environment and its application in planning. Recommendation of National building code., Green building, Introduction-Benefits, National priorities, rating system, check list, Site selection and planning, Water efficiency, Energy efficiency, Materials, Indoor environmental quality, Innovation and design process.

2. **Principle of Planning for differently abled publics**: Standardization and Contextualization of accessibility in built environment, Overview of accessibility codes (National and International Perspectives), Design for Inclusion : A holistic Approach (User centric approach to design, WINIT Model), Accessibility Elements of Built Environment in urban and rural Contexts (Kerb Ramps, Bollards, Level and gratings, Ramps, Gradients and other relevant elements) Principle of site planning and approaches for accessibility, Accessibility in public Sanitation System (Washroom typologies and Accessibility perspectives emergency evacuation systems and codes)

3. **Planning of Building: -**

   Preparation of constructional details and drawings-plan, elevation, section, site plan, foundation plan, terrace plan, waterproofing treatment, typical door and window.

   Planning of building such as

   Residential building –Load bearing structure, RCC framed structure. Building for Education – school, college. Library

   Building for health –Dispensary, Hospital Industrial structure

   Building for entertainment-Theatre, club house, sports club. Other structure-Office, Hostel, Guest house.

4. **Building's Water Supply and Drainage & Solid Waste Collection and Disposal System: -**

   Design of water supply, waste water and storm water collection system for various types of

buildings. Pumps and Pump House.

Wet and dry solid waste segregation, Vermi-composting etc. Provision of Chutes.

Accessibility in public Sanitation Systems.

5. **Electrical Services: -**

Domestic Supply, Distribution Circuits, basic wiring systems. Design and planning: - Lighting of staircase, corridors. Automatic Water Level controller, Closed Circuit Security Monitors with Intercom/ EPBX facility, Common Dish TV antenna, Use of Solar Panels as source of power, Lightening Conductor for High-rise Buildings.

6. **Fire Protection System: -**

Introduction, Fire protection, requirement of water quantity estimation. Systems of firefighting external and internal. Wet and dry risers, smoke alarm, Sprinkler system. Safety corridors in High-rise structures.

7. **Elevators: -**

Introduction, types of elevators. Essential features of lifts its size and requirement of minimum numbers, norms for safety doors, Operation and maintenance, Safety norms. Control systems, electrical requirement, and generator back-up, Escalators in Industry and in malls-multiplex. Design of Accessible Circulation System for differently abled publics.

8. **Heating Ventilation and Air Conditioning-**

Ventilation, functional requirement, Heat balance system of ventilation, General rules and regulations in artificial ventilation system, Central air conditioning: - ducting and glass claddings. Operation and maintenance.

9. **Building Management System: -**

Security Guard's Cabin, Postage collection boxes, Parking space.

Text Books

1. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871).

2. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805)

Recommended Reading:

1. Bureau of Indian Standards, " HAND BOOK OF FUNCTIONAL REQUIREMENTS OF BUILDINGS, (SP-41 & SP- 32)", BIS 1987 and 1989, (SP-41: ISBN: 8170610117)

2. Croome, J. D. & Roberts, B. M., "AIR-CONDITIONING AND VENTILATION OF BUILDINGS VOL-1". Pergamon Press, (ISBN: 0080247792)

3. SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095)

4. N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

Building Planning and Computer Aided Civil Engineering Drawings (Laboratory)

Course Content:

1. Preparation of detailed constructional plan of a residential building.

2. Preparation of front elevation, detailed sectional view, site plan, foundation plan, terrace plan, waterproofing treatment, typical door and window.

3. Concept of perspective drawing- one point, two-point, three point and uses.

4. Preparation of line plans of various public buildings like:

   Building for Education – School, College. Library

   Building for health –Dispensary, Hospital Industrial structure

   Building for entertainment-Theatre, Club House, Sports Club.

   Other Structure- Office, Hostel, Guest house.

5. Prepare layout for water supply and drainage for a residential building and for multistoried buildings.

6. Building's Solid Waste Collection and disposal system: Wet and dry solid waste segregation, Vermi-composting etc. Provision of Chutes.

7. Fire Protection System: Design of emergency exits and emergency vehicle routes with fire protection symbols

Text Books

1. Scott Onstott, AutoCAD 2018 and AutoCAD LT 2018 Essentials, Wiley (2017), (ISBN: 9788126569298)

2. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871).

3. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805)

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3. SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095)

4. N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

PCC -02	Concrete Technology	2L:0T:2P	4 credits

Course Outcomes

After completion of this course, the students will be able to,

1. Define the functional role of all ingredients of concrete and their use for normal and special purpose concrete.

2. Apply the principle of sustainability for the utilization of waste, novel and innovative materials for use in concrete.

3. Formulate concrete mix for normal and special purpose concrete.

4. Use of various non-destructive testing procedure for evaluation of concrete properties.

Course Contents

1. **Properties of ingredients**

   Properties of coarse and fine aggregates and their influence on concrete, types of cement and their use, Grades of ordinary Portland cement, Portland pozzolana cement, rapid hardening Portland cement, hydrophobic cement, low heat Portland cement and sulphate resisting Portland cement as per relevant I.S. codes. Types of aggregates and their properties. Testing of aggregates as per relevant IS Codes.

2. **Properties of different types of concrete**

   Concrete for structural work, light weight concrete, high density concrete, biological concrete, workability, durability and strength requirements, effect of w/c ratio on properties of fresh and hardened concrete, acceptability criteria, laboratory testing of fresh and hardened concrete, Fire resistant properties of hardened concrete.

3. **Concreting methods**

   Process of manufacturing of concrete, transportation, placing, compaction and curing of concrete. Extreme weather concreting, special concreting methods, vacuum dewatering– underwater concrete, special form work., Plum Concrete, Self-Compacting Concrete

4. **Admixtures**

Plasticizers, Retarders, Accelerators and other Admixtures, Test on Admixtures, Chemistry and Compatibility with concrete. GGBS fly Ash, Metakaolin, Silica Fumes, crush sand,

5. **Ready mix concrete**

Requirements of ready-mix concrete, properties of RMC, transit mixer details, Automation, instrumentation and Layout of RMC plant.

6. **Concrete mix design**

Mix Design for compressive strength by I.S. methods, road note method, British method, ACI Method, Mix design for flexural strength.

7. **Concrete for repairs and rehabilitation of structures**

High Performance concrete, Polymer Concrete, Fiber Reinforced Concrete, Light weight concrete and its manufacture, Polymer Impregnated Cement Concrete, Polymer Modified cement concrete and Ferro Cement, Special Tests for concrete used for repairs and rehabilitation.

8. **Non-destructive testing of concrete**

Rebound hammer test, Ultrasonic pulse velocity test, Magnetic particle testing, Liquid penetration testing, Visual testing, Laser Testing methods, Leak Testing, Impact echo test, carbonation test, Half cell potentiometer and corrosion of steel, Core test and relevant provisions of I.S. codes.

Text Books

1. M.L. Gambhir, Concrete Technology, McGraw Hill Book Company, Fifth Edition, 2017. (ISBN- 1259062554, 978-1259062551).

2. M.S. Shetty, Concrete Technology, Theory and Practice, S. Chand Publication, Sixth Edition, 2018. (ISBN- 9788121900034,978-8121900034)

3. B.L. Gupta and A. Gupta, Concrete Technology, Jain Book Agency, 2013. (ISBN- 8180140407, 978-8180140402).

Recommended Reading

1. A.R. Santhakumar, Concrete Technology, Oxford University Press, New Delhi, 2018. (ISBN- 9780195671537, 978-0195671537).

2. A.M. Neville, Properties of Concrete, Pearson Publication, London, 2012. (ISBN- 978-

0273755807, 9780273755807).

3. IS 10262-(2009) Recommended Guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi, 2009.

4. IS10262 (2009), Mix Design

5. IS269 (2015), Ordinary Portland Cement (33 Grade).

6. IS12269 (2013), Ordinary Portland Cement (53 Grade).

7. IS650 (1991), Specification of Standard Sand. 8. IS383 (1970), Specification for Coarse and Fine aggregate.

| PCC -03 | Fluid Mechanics | 3L:0T:2P | 4 credits |

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.*

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

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.

IKS	Indian Knowledge System	2L:0T:0P	2 Credits
From Basket			

MNC AU-03	Disability, Accessibility and Universal Design	3L:0T:0P	0 Credits

Course Aim / Intent

To introduce the concepts of disability, accessibility and universal design

Course Objective:

1. To sensitize about the basic concepts of disability, diversity and accessibility in built environments.

2. To introduce the key policy frameworks for legislative and technical perspectives of access.

3. To develop an insight into the understanding of universal design as an approach

S.No.	LECTURE TITLES	BROAD CONTENTS
1.	Human Diversity and Inclusion: An Introductory Perspective	Understanding concepts of diversity (may please include all vulnerable groups), inclusion, need and significance, impacts
2.	Understanding Disability: Definitions, Models and Prevalence	Theory of disability, Various concepts and models, Prevalence
3.	Disability Types and Environmental Needs - I	Disability Classification, functional limitations and key coping strategies in the environment For eg. Physical, Movement disabilities, Vision Impairments
4.	Disability Types and Environmental Needs - II	Hearing, Speech, Cognitive, Learning and other disabilities as per the RPWD Act 2016
Exercises: Role play, user interaction/interviews, observations, and engagement of user experts		
5.	Environmental Barriers: Introduction & Classification	Physical, Social, Institutional Barriers in diverse National and International Contexts

6.	Introduction to Harmonized Guidelines, NBC, and other exemplary international codes and guidelines	Basics of Accessibility Codes and their review
7.	Legislative Policies and Programs	UNCRPD, RPWD Act, 2016, SDGs, and urban development programs in Indian context other international and national policies

Review Discussions / Presentations on Experiential understanding of barriers, legislative rights and technical

8.	Universal Design Theory – I	Evolution from Barrier Free Environment to Universal Design, Definitions, Associated Myths and Concepts, Terminologies and Perspectives
9.	Universal Design Theory - II	Universal Design Principles (International, Indian, UD goals) and their criteria
10.	Universal Design Case Studies	Built Environment Case Studies from Urban Transportation and other contexts like peri urban, rural settings.

Case Study Reviews or a Small Design Exercise on Universal Design reflecting the understanding of Universal Design

SEMESTER -IV

PCC-04	Transportation Engineering	2L:0T:2P	3 Credits

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: Accessibility to Differently Abled Publics
Design of Access Routes &Walkways (Elements of walkways, Tactile Navigation Systems, BRT Systems, Pedestrian streets and other related aspects), Accessible Streets and Mobility Environments (Street Elements for Accessibility, dimensions and codes material, TGSIs), Inclusive Public Transportation System

Module 4: 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 5: 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 6: 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- 05	Surveying and Geomatics	3L:0T:2P	4 Credits

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.

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- 06	Geotechnical Engineering	3L:0T:2P	4 Credits

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.

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

☐ Understand the different types of soil based on their formation mechanism;

☐ Understand the various phase diagrams and derive various phase relationships of the soil;

☐ Perform various laboratory experiments to determine moisture content, specific gravity;

☐ Perform field experiments to estimate the field density of the soil mass.

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.

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.

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

6. Essentials of Soil Mechanics and Foundations: Basic Geotechnics by David F. McCarthy

7. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri.

8. Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering (Civil and Environmental Engineering) by V.N.S. Murthy

PCC- 07	**Hydraulic Engineering**	**3L:0T:2P**	**4 Credits**

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.

Practical Work:
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

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- 08	Structural Analysis	3L:1T:0P	4 Credits

Course Outcomes

After completion of this course, students will be able to,

1. Determine deflection of statically determinate structures under various loading and support conditions.

2. Apply basic concepts of structural mechanics for the analysis of statically determinate structures.

3. Apply concepts of structural mechanics for the analysis of statically determinate arches and stiffened suspension bridges.

4. Apply concept of Influence Line Diagram to statically determinate structures.

5. Analyze indeterminate structures by using force method.

6. Analyze indeterminate structures by using displacement method.

Course Contents

1. General theorems

Theorems relating to elastic structures, principle of virtual work, strain energy in elastic structures, complementary energy, Castigliano's theorems, Maxwell-Betti's reciprocal theorem.

2. Deflection of statically determinate structures

Deflection of determinate beams by double integration (Macaulay's) method, moment area and conjugate beam methods, principle of virtual work (unit load method) and Castigliano theorems, Deflection of determinate pin jointed trusses and rigid jointed frames by principle of virtual work (unit load method), Strain Energy and Castigliano theorems.

3. Influence lines for statically determinate structures

Influence lines for cantilever beam, simply supported beam, overhanging beam and pin jointed trusses. Criteria for maximum shear force and bending moment under moving loads for simply supported beams, absolute maximum bending moment.

4. Elastic arches

Normal thrust, shear force and bending moment for parabolic and segmental three hinged arches. Influence lines for normal thrust, shear force and bending moment for three hinged parabolic arch.

5. Suspension bridges

Suspension cable with three hinged stiffening girder. Influence line diagrams for horizontal tension in the cable, shear force and bending moment at any section of the stiffening girder.

6. **Column and Struts**

   Struts subjected to axial loads, concept of buckling. Euler's buckling theory of struts with different boundary conditions. Rankine's buckling theory for columns. Struts subjected to eccentric and lateral loads and struts with initial curvature.

7. **Analysis of indeterminate structures by flexibility method**

   Flexibility coefficients and their use in the formulation of compatibility equations. Application of Castigliano's theorem of least work to propped cantilevers, fixed beams, continuous beams, simple pin jointed frames including effect of lack of fit of members, simple rigid jointed frames and two hinged arches.

8. **Analysis of indeterminate structures by stiffness method**

   Stiffness coefficients and their use for formulation of equilibrium equation, direct stiffness method, slope deflection method, moment distribution method, applications of these methods to indeterminate beams, simple rigid jointed frames and rigid jointed frames with inclined members, including the effect of settlement/rotation of supports.

   Text Books

1. S.B Junnarkar, Structural Mechanics Volume I, and II Charotar Publishers, 2016. (ISBN:978-9385039270).

2. D. Menon, Structural Analysis Volume – I and II Narosa Publication, 2010. (ISBN- 978-1842653371/1842653377).

3. C.S. Reddy, Basic Structural Analysis, Publisher: Tata McGraw Hill, 2010. (ISBN-1283187140/978-1283187145).

   Recommended Reading

1. C.K. Wang, Intermediate Structural Analysis, McGraw Hill, 1984. (ISBN-10:0070666237/978-0070666238).

2. B.G. Neal, Structural theorems and their application, Pergaman Press, 1972. (ISBN:978-1483139029).

3. S.S. Bhavikatti, Structural Analysis Volume – I, Vikas Publishers, 3rd edition, 2011. (ISBN: 9788125942696/8125942696).

4. S. Timoshenko and Young, Theory of Structures, Publisher: Tata McGraw Hill, 1965. (ISBN-9780070648685/978-0070648685).

5. Norries and Wilbur, Elementary Structural Analysis, Publisher: McGraw Hill, 1990. (ISBN-0071008365/978-0071008365).

6. H I Laursen, Structural Analysis, Publisher: McGraw Hill, 1988. (ISBN-0070366454/978-0070366459).

7. B.N. Thadani and J.P. Desai, Modern Methods in structural Analysis, Weinall Book Corporation, 1998. (ISBN-021026957X/978-0210269572)

8. Pandit and Gupta, Matrix Method in Structural Analysis, Tata McGraw Hill, 2008. (ISBN-0070667357/978-0070667358)

9. L.S. Negi and R.S. Jangid, Structural Analysis, Tata McGraw Hill, 2008.

10. Gupta and Pandit, Structural Analysis Vol. I & II, Tata McGraw Hill,2008. (ISBN-0070667357/978-0070667358)

11. Gare and Weaver, Analysis of Framed Structure, CBS Publication, 2nd Edition, 2004. (ISBN:978-8123911519/8123911513).

PCC- 09	**Construction Engineering and Management**	**3L:0T:0P**	**3 Credits**

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

MNC-AU- 04	Civil Engineering – Societal & Global Impact	3L:0T:0P	0 Credits

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;

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:

 The impact which Civil Engineering projects have on the Society at large and on the global arena and using resources efficiently and effectively.

 The extent of Infrastructure, its requirements for energy and how they are met: past, present and future

 The Sustainability of the Environment, including its Aesthetics,

 The potentials of Civil Engineering for Employment creation and its Contribution to the GDP

 The Built Environment and factors impacting the Quality of Life

  The precautions to be taken to ensure that the above-mentioned impacts are not adverse but beneficial.

 Applying professional and responsible judgement and take a leadership role;

SEMESTER -V

PCC- 10	Structural Design -I	3L:0T:2P	4 Credits

Course Outcomes

After completion of this course, students will be able to,

1. Implement concept of working stress method for analysis and design of RCC structural elements.

2. Implement concept of limit state method for analysis and design of RCC structural elements.

3. Apply principles of pre-stressed concrete for design of PC sections.

Course Contents

1. **Working stress method and ultimate load method of design**

   Reinforced Concrete Fundamentals (working Stress Method): Concept of reinforced concrete, stress strain characteristics of concrete and steel reinforcement, elastic theory, singly reinforced, balanced section, under reinforced section and over reinforced section.

2. **Limit state method of design**

   Concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to limit states of collapse in flexure, direct compression, shear and limit states of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure. Design of members in shear and bond. Design of columns for Axial Load, Uni-axial bending moment and Bi-axial bending moment as per IS Code method. Design of one-way and two-way slabs. Design of beam subjected to bending and torsion. Design of Isolated square and rectangular footings subjected to axial load and moments, Design of combined foundations. Design of Doglegged, Open well type staircases. Design of Flat slab and Post tensioned slab

3. **Pre-stressed concrete**

   Basic principles of pre-stressed concrete: materials used and their properties, methods and systems of pre-stressing. Losses in pre-stress, analysis of various types of sections subjected to pre-stress and external loads. Prestressed and post tensioned members, Different types of Prestressed sections , BoxSection, Girder

Text Books

1 Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, Nemchand Brothers.(ISBN-8185240086/978-8185240084).

2 V. L. Shah and Karve, Limit State Design - Reinforced Concrete Structures Publications. (ISBN-9788190371711/8190371711).

3 N. Krishna Raju, Pre-stressed Concrete, Tata McGraw Hill. (ISBN-9789387886209/9387886204).

.**Recommended Reading**

1. P. Dayaratnam, Design of Reinforced Concrete Structures, Oxford & IBH. (ISBN-9789386479785/9386479788).

2. T.Y. Lin, Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 2010. (ISBN-9788126528035/978-8126528035).

3. P.D. Arthur and V. Ramkrishnan, Ultimate Strength Design for Structural Concrete, Wheeler &Co. Pvt Ltd. (ISBN- 0273403230, 978-0273403234).

4. B.P. Hughes, Limit State Theory for Reinforced Concrete Design, Pitman. (ISBN- 0273010239, 978-0273010234).

5. IS456 (2000), Plain and Reinforced Concrete.

6. IS 875 (1987), Part I- Design Loads (Other than earthquake) for Buildings and Structures (Dead Loads).

7. IS 875 (1987), Part II- Design Loads (Other than earthquake) for Buildings and Structures (Imposed Loads).

8. IS 875 (2015), Part III- Design Loads (Other than earthquake) for Buildings and Structures (Wind Loads).

9. IS 875 (1987), Part IV- Design Loads (Other than earthquake) for Buildings and Structures (Snow Loads).

Structural Design -I   Laboratory

Course Outcomes

After completion of this course, students will be able to,

1. Analyze and design beam, column, slab, foundation, staircases and cantilever and counterfort retaining walls.

2. Draw detailed structural drawings for slab, beam, column, foundation, staircases and cantilever and counterfort retaining walls.

Course Contents

1. Design and drawing of singly reinforced, doubly reinforced rectangular and T-section simply supported and continuous beam.

2. Design and drawing of one way, two way simply supported and continuous slab system.

3. Design and drawing of Dog-legged and open wall type staircases.

4. Design and drawing of columns and foundation.

5. Design and drawing of Retaining wall. (Cantilever and counterfort)

Text Books

1. Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, Nemchand Brothers.(ISBN-8185240086/978-8185240084).

2. V.L. Shah and Karve, Limit State Design - Reinforced Concrete Structures Publications. (ISBN-9788190371711/ 8190371711).

3.K. Raju, Pre-stressed Concrete, Tata McGraw Hill.(ISBN- 9789387886209/9387886204).

Recommended Reading

1. P.Dayaratnam, Design of Reinforced Concrete Structures, Oxford & IBH. (ISBN-9789386479785/9386479788).

2. T.Y. Lin, Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 2010. (ISBN-9788126528035/8126528036).

3. P.D.Arthur and V.Ramkrishnan, Ultimate Strength Design for Structural Concrete, Wheeler&Co. Pvt Ltd. (ISBN- 0273403230/978-0273403234).

4. B.P. Hughes, Limit State Theory for Reinforced Concrete Design, Pitman. (ISBN-0273010239/978-0273010234).

| PCC- 11 | Environmental Engineering | 3L:0T:2P | 4 Credits |

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.

Practical Work: List of Experiments
1. Physical Characterization of water: Turbidity, Electrical Conductivity, pH
2. Analysis of solids content of water: Dissolved, Settleable, suspended, total, volatile, inorganic etc.
3. Alkalinity and acidity, Hardness: total hardness, calcium and magnesium hardness
4. Analysis of ions: copper, chloride and sulfate
5. Optimum coagulant dose
6. Chemical Oxygen Demand (COD)
7. Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD)
8. Break point Chlorination
9. Bacteriological quality measurement: MPN,
10. Ambient Air quality monitoring (TSP, RSPM, SOx, NOx)
11. Ambient noise measurement

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.

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- 12	Engineering Economics, Estimation & Costing	3L:0T:2P	4 Credits

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)

Term Work Assignments may include:

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.

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

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.

PCC- 13	Hydrology and Water Resource Engineering	3L:0T:0P	3 Credits

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.

PCE- 01	Program Elective Course	3L:0T:2P	4 Credits

From Track

MOPCE- 01	Multidisciplinary Open Elective Course	3L:0T:0P	3 Credits

From Basket

MNC -AU-05	**Professional Practice, Law and Ethics**	**3L:0T:2P**	**0 Credits**

Basic elements of civil engineering professional practice are introduced in this course. Roles of all participants in the process-owners, developers, designers, consultants, architects, contractors, and suppliers - are described. Basic concepts in professional practice, business management, public policy, leadership, and professional licensure are introduced. The course covers professional relations, civic responsibilities, and ethical obligations for engineering practice. The course also describes contracts management, and various legal aspects related to engineering. Further, the course familiarizes students with elementary knowledge of laws that would be of utility in their profession, including several new areas of law such as IPR, ADR.

The course is designed to address the following:

- ☐ To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession
- ☐ To develop some ideas of the legal and practical aspects of their profession

Proposed Syllabus

Professional practice covering the respective roles of the various stakeholders in the profession of civil engineering and the factors governing the same; Professional ethics relating to civil engineering; Various aspects of contracts relating to construction and management of contracts; types of contractual and other disputes in the profession and

methods of dispute resolution; legal aspects relating to employment and service conditions of labour; intellectual property rights and their legal framework

Modules:

Module 1 A- Professional Practice – Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role

governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Module 1 B- Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module 2:*General Principles of Contracts Management: Indian Contract Act, 1972 and amendments* covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /" Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

Module 3 :*Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system:* Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats

Module 4 :*Engagement of Labour and Labour & other construction-related Laws:* Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module 5 : *Law relating to Intellectual property:* Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;

Text/Reference Books:

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
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. Neelima Chandiramani (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. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.

11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House

12. Bare text (2005), Right to Information Act

13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers

14. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act

15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House

16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2,pp 117-127, MCB UP Ltd

17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application

18. Ethics in Engineering- M.W.Martin& R.Schinzinger, McGraw-Hill

19. Engineering Ethics, National Institute for Engineering Ethics, USA

20. www.ieindia.org

21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins

22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm

23. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html

24. Contract&Agreements http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm

25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt

26. Business & Personal Law. Chapter 7. "How Contracts Arise", http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt

27. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt

28. IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS, http://www.worldbank.org/html/opr/consult/guidetxt/types.html

29. Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02), http://www.sandia.gov/policy/14g.pdf

Goals & Outcomes:

 To familiarise the students to what constitutes professional practice, introduction of various stakeholders and their respective roles; understanding the fundamental ethics governing the profession

 To give a good insight into contracts and contracts management in civil engineering,

dispute resolution mechanisms; laws governing engagement of labour

☐ To give an understanding of Intellectual Property Rights, Patents.

☐ To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession

☐ To develop good ideas of the legal and practical aspects of their profession

SEMESTER -VI

PCC- 14	Structural Design -II	3L:0T:2P	4 Credits

Course Outcomes:

After completion of course, students will be able to,

1. Apply the limit state design philosophy for analysis and design of structural steel components.
2. Apply the limit state design philosophy for analysis and design of structural steel connections.
3. Analyze and design structural steel roofing and flooring systems.

Course Contents

1 Bolted and welded connections

Introduction to riveted connection, design of bolted and welded connections, axially and eccentrically loaded joints, simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, unstiffened and stiffened seat connections.

2 Roofing system

Imposed loads on flat and sloping roofs and floors, wind loads on sloping roofs and vertical cladding including effect of degree permeability and wind drag, analysis of pin-jointed trusses under various loading cases, computation of design forces in members, design and detailing of connections and supports.

3 Flooring system

Concept of floor system with secondary beams, main beams and columns, design of simply supported beams using rolled steel sections.

4 Columns and bases

Design of columns under axial loads using single or multiple rolled steel sections, design of lacing, battens, columns subjected to axial load and bending, design of slab and Gusseted base.

Text Books :

1. S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
2. V.L. Shah and V. Gore, Limit State Design of Steel Structures IS:800-2007, Structures Publication, 2012. (ISBN: 8190371754).

Recommended Reading:

1. S.S. Bhavikatti, Design of SteelStructures, I.K. International Publishing House Limited, 2017.(ISBN: 9789385909559/938590955X).

2. N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815/0198068816).

3. IS 800 (2007), General Construction in Steel- Code of Practice, Ced 7: Structural Engineering and Structural Section, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

4. IS 875- Part 1 (1987): Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

5. IS 875- Part 2 (1987): Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

6. IS 875- Part 3 (2017): Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

7. IS 875- Part 4 (1987): Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi.

8. IS 875- Part 5 (1987): Special Loads and Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Published by Bureau of Indian Standard ManakBhavan, New Delhi

Structural Design-II Laboratory

Course Outcomes:

After completion of course, students will be able to,

1. Identify and compute the design loads on various structural steel systems.

2. Apply principles and relevant codal provisions for the analysis and design of various structural steel systems.

3. Use commercial software for analysis and design of steel structures.

4. Prepare detailed structural drawings for any given design.

Course Contents:

    A. Design of roof truss system.

    B. Design of columns and columns bases.

    C. Design of structural steel flooring system.

    D. Design of bolted and welded connections.

PCC- 15	Intelligent Transportation Systems	3L:0T:0P	3 Credits

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

PCC- 16	Sustainable and Green Construction	3L:1T:0P	4 Credits

Introduction to sustainable Development: Definition and principles of sustainable development, Historical context and evolution of sustainability, Global and local challenges related to sustainability.

Environment Science and Ecology: Fundamentals of ecology, Biodiversity and conservation, Climate change and its impacts, Environmental pollution and waste management.

Sustainable construction Material and Technology: Green building materials and technologies, Life cycle assessment of materials, Resource efficiency and waste reduction in construction, Low-impact construction methods

Energy Efficiency in Buildings: Principles of energy-efficient design, Renewable energy integration in building design, Energy-efficient HVAC systems, Building energy modeling and simulation

Water Management in Construction: Sustainable water use in construction processes,

Rainwater harvesting and greywater recycling, Water-efficient construction practices, Strategies for mitigating water pollution on construction sites

Sustainable Site Planning: Site selection and evaluation for sustainable construction, green space planning and landscaping, Sustainable stormwater management,

Sustainable Building Design: Principles of green building design, Passive design strategies for energy efficiency, Daylighting and natural ventilation, Integration of sustainable technologies in design

Construction and Demolition Waste Management: Waste reduction and recycling in construction, Responsible demolition practices, Circular economy concepts in construction.

Building Certifications and Standards: LEED (Leadership in Energy and Environmental Design) certification, BREEAM (Building Research Establishment Environmental Assessment Method), Other regional and international green building certifications

Environmental Regulations and Policy: - Building codes and regulations for sustainable construction - Environmental impact assessments - Government policies promoting green construction

Economics of Sustainable Construction: - Cost-benefit analysis for green building projects - Financial incentives for sustainable construction - Business models for green technologies in construction

Project Management for Sustainable Construction: - Sustainable project planning and execution - Stakeholder engagement and communication - Monitoring and evaluating sustainability performance

Ethics and Social Responsibility in Construction: - Ethical considerations in sustainable construction - Social impacts of green construction projects - Community engagement and stakeholder involvement.

PCE- 02	Program Elective Course	3L:0T:2P	4 Credits

From Track

PCE- 03	Program Elective Course	3L:0T:2P	4 Credits

From Track

MOPCE- 02	Multidisciplinary Open Elective Course	3L:0T:0P	3 Credits

From Basket

MNC AU-06	Instrumentation & Sensor Technologies for Civil Engineering Applications	3L:0T:0P	0 Credits

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

Practical's:

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

SEMESTER -VII

PCC- 17	Robotics and Automation	2L:0T:0P	2 Credits

Introduction to Robotics and Automation: Definition and basic principles of robotics and automation, Historical perspective and evolution, Applications in civil engineering

Fundamentals of Civil Engineering: Overview of civil engineering disciplines (structural, geotechnical, transportation, etc.), Basic principles of construction and infrastructure development

Sensors and Actuators: Types of sensors used in civil engineering applications, Actuators and their role in automation, Integration of sensors and actuators in robotic systems

Robot Kinematics and Dynamics: Basics of robot motion and manipulation, Forward and inverse kinematics, Dynamics of robot motion

Robotics in Construction: Autonomous construction vehicles, Robotic construction equipment, Robotic assembly and fabrication in construction

Automation in Structural Engineering: Automated inspection and maintenance of structures, Robotic construction of buildings and bridges, Structural health monitoring using automation

Unmanned Aerial Vehicles (UAVs) in Civil Engineering: Aerial surveying and mapping, UAVs for site inspection and monitoring, Applications in geotechnical engineering and slope stability analysis

Automation in Geotechnical Engineering: Automated soil sampling and testing, Autonomous drilling and excavation in geotechnical applications, Robotics in tunneling and underground construction

Human-Robot Collaboration: Collaborative robots (cobots) in civil engineering, Safety considerations in human-robot interaction, Case studies of successful human-robot collaboration in construction

Robotics in Disaster Response and Recovery: Use of robots in disaster-stricken areas, Search and rescue robotics, Automated infrastructure inspection after disasters

Machine Learning and Artificial Intelligence in Civil Engineering: Introduction to machine learning and AI, Applications in predictive maintenance, AI-driven decision-making in civil engineering projects

Legal and Ethical Considerations: Regulations and standards for robotics in civil engineering, Ethical considerations in the use of automation, Liability and safety standards

PCE- 04	Program Elective Course	3L:0T:2P	4 Credits

From Track

MOPCE- 03	Multidisciplinary Open Elective Course	3L:0T:0P	3 Credits

From Basket

Six Month Internship

Notes:

1. Semester VII will start from 15th June – 15th December (Six-months mandatory internship). Courses listed in semester VII will be conducted in Online mode/Swayam/NPTEL/Coursera etc. so that students can spend full time on Internship.

2. Semester VII and VIII can be swapped.

3. If all students are not getting full time Industry Internship, then one group will do VIII semester Courses and another group will do the full-time Internship along with online courses assigned with internship and vice versa .

4. In lieu of Internship students can also implement their own ideas through start-ups (this will encourage an entrepreneurial environment in college and society).

MNC -AU-07	**Disaster Preparedness & Planning Management**	**3L:0T:0P**	**0 Credits**

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 environmentally friendly recovery; reconstruction and development methods.

Module 6: Accessibility in Disaster Contexts and Emergency Services for differently abled publics (Accessibility in context of Disaster Preparedness, Response, Mitigation and reconstruction)

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

SEMESTER -VIII

PCE- 05	Program Elective Course	3L:0T:2P	4 Credits

From Track

PCE- 06	Program Elective Course	3L:0T:2P	4 Credits

From Track

PCE- 07	Program Elective Course	3L:0T:2P	4 Credits

From Track

MOPCE- 04	Multidisciplinary Open Elective Course	3L:0T:0P	3 Credits

From Basket

Project

ANNEXURE-A

SYLLABUS FOR BASKET OF ELECTIVE COURSES OF ELECTED TRACKS

IMPORTANT NOTE: *Only keywords/topics of the course/subject is mentioned. This is in order to detail or condense as per the requirement and assign appropriate credits. Suggested credit for any course is either 2 or 3. Prerequisites are to be decided by the concerned faculty keeping in mind the track/thread/stream of courses taken by the student earlier.*

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:

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:

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.

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.

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:

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

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.

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.

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.

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 solutionsfor transport problems; Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – urban development planning policy - Case studies.

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,

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.

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.

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.

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.

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.

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

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;

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

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 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:

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:

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:

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:

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:

Stream Ecology. Description of physical, chemical, and biological characteristics in streams and rivers including an integrated treatment of the environmental factors affecting the composition and distribution of biota; emphasizes the application of ecological engineering principles in aquatic ecosystem protection.

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:

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.

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

<u>Systems</u>: 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. <u>Sanitary</u> <u>Sewerage</u> <u>Systems</u>: 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. <u>Storm water Drainage Systems:</u> 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.

Air and Noise Pollution 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 layerdisturbance, 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

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.

Water and Air Quality Models. 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 .

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.

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

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

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

Groundwater Engineering: The main objective is to provide sufficient knowledge to the students about the groundwater hydrology, well hydraulics and well construction, geo- physical explorations, groundwater quality and management of groundwater resources; Problems and perspectives regarding groundwater in India; Hydrogeology: Darcy's Equation; flow characteristics; general flow equations; unsaturated flow; Well Hydraulics: Steady and unsteady radial flows in aquifers; partially penetrating wells; multiple well systems; characteristic well losses; specific capacity, Surface and Subsurface investigations (Geologic methods; remote sensing; geophysical explorations; electrical resistivity and seismic refraction), Water Wells: Construction; completion, development, protection and rehabilitation of wells; Groundwater quality; Groundwater Management: Basin management, investigations, conjunctive use, modeling, artificial recharge; Saline water intrusion

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.

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.

Hydraulic Analysis and Design. Hydraulic analysis and design of engineering systems: closed conduits and pipe networks; hydraulic structures, including spillways, stilling basins, and embankment seepage; selection and installation of hydraulic machinery.

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.

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.

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.

Structural Analysis-I. 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.

Structural Analysis-II. 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.

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.

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

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

Metal Structure Behavior- I. 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.

Metal Structure Behavior-II. Metal members under combined loads; connections, welded and bolted; moment- resistant connections; plate girders, conventional behavior, and tension field action.

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.

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.

Design of Concrete Structures-I. 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 Concrete Structures-II. Design of continuous beams and building frames, Moment redistribution, Estimation of wind and seismic loads, Desirable features of earthquake resistant construction, Detailing for earthquake resistant construction – ductility criteria; Water tank and

staging; Introduction, Design criteria, Design of rectangular and circular water tank, Design of Intze tank, Staging for overhead 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 simple span girders, Design of end block; Design of staircases; Design of cantilever and counter- forte type retaining wall; All design steps/process to as per the most recent BIS code of practices

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;

Construction Practice. Building planning, site selection, orientation from environmental and other factors, principles of planning buildings, open air spaces, requirement of parts of buildings, lighting and ventilation, requirements of various rooms, Building bye laws. Components of building and their purpose and types; foundations, walls, columns, roofs,doors, windows; Bands and openings in the buildings; seismic requirements; Mechanical, Electrical & Plumbing (MEP) works in buildings; Vertical transport in structures; Building finishes; Basic design of foundation of buildings, Terms used in brick masonry, Bonds and types of mortars. Excavation, dewatering, shoring, underpinning and scaffolding, drilling, blasting, well sinking and pile driving, cofferdams, form work-fabrication and use. Construction techniques for special structures such as slip forming and other special formwork systems for high-rise buildings, Damp proofing; causes and effect of dampness, materials and methods of damp proofing; Termite proofing: pre and post construction treatment; Thermal insulation, methods of thermal insulation, thermal insulation of roofs and exposed walls; Doors and windows, Staircases: parts and type of stairs, dimensioning of stair case. Internal and external painting-types and methods of application; various types of finishes; Fire protection- fire hazards, characteristics of fire-resisting materials and common building materials; Cracks in walls,

floors and ceilings-causes and repairs techniques; Routine maintenance of buildings and structures.

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.

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.

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.

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.

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.

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

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.

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.

Soil Mechanics-I. 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:

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 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.

Soil Mechanics-II. 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 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.

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

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.

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.

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.

Civil Engineering Design-I. 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.

Civil Engineering Design-II. 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.

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.

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

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.

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.

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.

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:

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

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.

Evaluating Accessibility / Universal Design in Built Environments

Introduction to Access Audits: Basic concept of accessibility audits and what it means from various perspectives. Types and Tools of Audits: Specific tools, checklists and methods of evaluation. Developing Audit Tools: Learning how to customize and contextualize evaluation perspectives for various elements of built environment, Participatory ap-proaches. Evaluating accessibility in External Built Environments – I: Protocols and Process of access evaluation, Scale of Accessibility in context of outdoor / site elements. Evaluating accessibility in External Built Environments – II: Examples and Case Studies. Evaluating Access for Internal Elements of Built Environment – I: Protocols and Process of access evaluation, Scale of Accessibility in

context of indoor elements. Evaluating accessibility in External Built Environments - II : Examples and Case Studies. Accessible Building Technologies – I: Basic and innovative technologies for built environment. Accessible Building Technologies – II: Advanced technologies for accessibility in built environments. Accessibility Evaluation in Housing Contexts: Accessibility in Housing perspectives. Accessibility in Education Environments: Accessibility perspectives for inclusion in school environments, special needs. Evaluating accessibility in Urban Public Spaces & Public Transporta-tion Systems: Focusing on urban public space elements along with public transportation systems. Concluding Talks: Access Evaluation, Retrofitting and Way forward: Concluding remarks, Way Forward

Suggested online Value Added SWAYAM Course(s) for students to understand the requirements/needs of differently abled publics.

1. Children with Developmental Challenges
   Mrs.V.Kavitha Kiran | The English and Foreign Languages University (Host University)
   https://onlinecourses.swayam2.ac.in/cec20_ed08/preview

2. Disability Studies: An Introduction
   Prof. Hemachandran Karah | IIT Madras
   https://onlinecourses.nptel.ac.in/noc19_hs58/preview

3. Neuroscience of Human Movements
   Prof. Varadhan SKM | IIT Madras
   https://onlinecourses.nptel.ac.in/noc19_ge28/preview

4. Development of Assistive Technology for Persons with Disabilities
   Dr. Indumathi Rao | C B R Network
   https://onlinecourses.swayam2.ac.in/aic19_ge01/preview

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ANNEXURE-B
EXIT OPTIONS FOR CIVIL ENGINEERING

Level	Semester	Exit Option	Credits	Additional Credits for exit students	List of exit courses
4.5	Sem I &II	U.G Certificate	40	6-8	1. Materials and Civil Engineering (3-0-0 = 3 Credits) 2. Testing of Civil Engineering Materials (0 -0 -4 = 2 Credits) 3. Introduction to construction methodology and technics (3-0-0= 3 Credits) 4. Introduction to construction equipment's (3-0-0 = 3 Credits) 5. Site Supervision work (0 -0- 4= 2 Credits) 6. Survey Work (0-0-4 = 2 Credits) 7. Bar-Bending schedule work (0- 0 -4 = 2 Credits) 8. Introduction to Geodetic Surveying and Remote sensing (2-0-4=3 Credits) 9. Application of Autonomous Vehicle and Safety Regulations (2-0-2 = 3credits)
5.0	Sem III &IV	U.G Diploma	44	6-8	1. Advance Concrete Technology. (2-0-4 = 3 Credits) 2. Fundamentals of structural Design (2-0-0= 2Credits) 3. Quantity Survey and Estimation (2-0-4= 3 Credits) 4. Transportation Engineering (2-0-4= 3 Credits) 5. Geotechnical Engineering (2-0-4 = 3 Credits) 6. Sustainable Construction and Lean Construction (3 -0-0 = 3 credits) 7. Prefabricated structures (3-0-0= 3 Credits) 8. Environmental Impact Assessment (3-0-0 = 3 Credits) 9. Digital Construction lab (0-0-6 = 3 Credits) 10. Introduction to Building Information Modeling (BIM) (2-0-4 = 4 Credits)
5.5	Sem V &VI	B.E Vocational	44	6-8	1. Advance Concrete Technology. (2-0-4 = 3 Credits) 2. Design of RCC and Steel Structures (3-0-2 = 4 credits) 3. Formwork Engineering (2-0-2 = 3 credits) 4. Airports and Harbor (3-0-0 = 3 credits) 5. Construction Management and Safety (3-0-0 = 3 Credits) 6. Water Resource Management (3-0-0 = 3 credits) 7. Air and Noice pollution control engineering (3-0-0 = 3 credits) 8. Tunnel Engineering (3-0-0 = 3 Credits) 9. Introduction and Application of AI, ML and IOT for Civil Engineering (3-0-0 = 3 Credits) 10. Sustainable and green construction (3-0 -0 = 3 Credits)
6.0	Sem VII &VIII	B.E/B.Tech	40	--	
		B.E/B.Tech - Minor/ Honor's/Research	18	--	

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

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