NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SYLLABI
FOR B.TECH. PROGRAM

From 2017-18 Batch onwards

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION
B.Tech. (Civil Engineering) Course Structure

I - Year

Physics Cycle							
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101	Mathematics - I	3	0	0	03	BSC
2	HS101	English for Technical Communication	2	0	2	03	HSC
3	PH101	Physics	3	0	0	03	BSC
4	EC101	Basic Electronic Engineering	3	0	0	03	ESC
5	CE102	Environmental Science and Engineering	2	0	0	02	ESC
6	BT101	Engineering biology	2	0	0	02	ESC
7	CS101	Problem Solving & Comp Programming	3	0	0	03	ESC
8	CS102	Problem Solving & Comp Programming Lab	0	1	2	02	ESC
9	PH102	Physics Laboratory	0	1	2	02	BSC
10	EA101	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**18**	**2**	**9**	**23**	

Chemistry Cycle							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA151	Mathematics – II	3	0	0	03	BSC
2	ME102	Engineering Graphics	1	1	4	04	ESC
3	CY101	Chemistry	3	0	0	03	BSC
4	EE101	Basic Electrical Engineering	3	0	0	03	ESC
5	ME101	Basic Mechanical Engineering	3	0	0	03	ESC
6	CE101	Engineering Mechanics	3	0	0	03	ESC
7	ME103	Workshop Practice	0	1	2	02	ESC
8	CY102	Chemistry Laboratory	0	1	2	02	BSC
9	EA151	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**16**	**3**	**11**	**23**	

II – Year: I - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	MA211	Mathematical Methods	3	0	0	3	BSC
2	CE201	Strength of Materials	3	1	2	5	PCC
3	CE202	Fluid Mechanics-1	3	0	0	3	PCC
4	CE203	Surveying	3	0	0	3	PCC
5	CE204	Civil Engineering Materials	3	0	0	3	PCC
6	CE205	Remote Sensing	2	0	0	2	PCC
7	CE206	Fluid Mechanics Laboratory	0	1	2	2	PCC
8	CE207	Surveying Laboratory	0	1	2	2	PCC
		TOTAL	17	3	6	23	

II – Year: II - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	CE251	Mechanics of Materials	3	0	0	3	PCC
2	CE252	Fluid Mechanics-2	3	0	0	3	PCC
3	CE253	Design of Steel Structures	3	0	0	3	PCC
4	CE254	Building Planning & Construction	3	0	0	3	PCC
5	CE255	Concrete Technology	3	0	2	4	PCC
6	CE256	Engineering Geology	3	0	2	4	PCC
7	CE257	Hydraulic Engineering Laboratory	0	1	2	2	PCC
8	CE258	Building Drawing Laboratory	0	1	2	2	PCC
		TOTAL	18	2	8	24	

III – Year: I - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	CE301	Theory of Structures-1	3	0	0	3	PCC
2	CE302	Design of Concrete Structures	3	0	0	3	PCC
3	CE303	Engineering Hydrology	3	0	0	3	PCC
4	CE304	Geotechnical Engineering-1	3	1	0	4	PCC
5	CE305	Transportation Engineering-1	3	0	0	3	PCC
6	CE306	Environmental Engineering-1	3	0	0	3	PCC
7	CE307	Transportation Engineering Laboratory	0	1	2	2	PCC
8	CE308	Geotechnical Engineering Laboratory	0	1	2	2	PCC
9	EP349	EPICS	0	0	0	2*	
		TOTAL	18	3	4	23	

*Credits are not considered for computation of SGPA and CGPA

III – Year: II - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	CE351	Theory of Structures-2	3	0	0	3	PCC
2	CE352	Irrigation Engineering	3	1	0	4	PCC
3	CE353	Environmental Engineering-2	3	0	0	3	PCC
4	CE354	Transportation Engineering-2	3	0	0	3	PCC
5	CE355	Geotechnical Engineering-2	3	0	0	3	PCC
6		Open Elective-1	3	0	0	3	OPC
7	CE356	Civil Engineering Software Laboratory	0	1	2	2	PCC
8	CE357	Environmental Engineering Laboratory	0	1	2	2	PCC
9	EP399	EPICS	0	0	0	2*	
		TOTAL	18	3	4	23	

*Credits are not considered for computation of SGPA and CGPA

IV – Year: I - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	CE401	Quantity Surveying & Public Works	3	0	0	3	PCC
2	CE402	Construction Technology & Project Management	3	0	0	3	PCC
3		Open Elective-2	3	0	0	3	OPC
4		Dept. Elective-1	3	0	0	3	DEC
5		Dept. Elective-2	3	0	0	3	DEC
6		Dept. Elective-3	3	0	0	3	DEC
7	CE448	Seminar	0	0	2	1	PCC
8	CE449	Project Work Part-A	0	0	4	2	PRC
		TOTAL	18	0	6	21	

IV – Year: II - Semester

S.No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1		Engineering Economics & Project Appraisal	3	0	0	3	HSC
2		Department Elective-4	3	0	0	3	DEC
3		Department Elective-5	3	0	0	3	DEC
4		Department Elective-6	3	0	0	3	DEC
5		Department Elective-7	3	0	0	3	DEC
6	CE499	Project Work Part-B	0	0	8	4	PRC
7		Mandatory Audit Course (Self Study) *	0	0	0	0	MDC
		TOTAL	15	0	8	19	

*The result of the Mandatory Audit Course (Self Study) completed by the student either in 6^{th} or 7^{th} semester will be reported in this semester

	Credits in Each Semester									
	1	2	3	4	5	6	7	8	TOT	REQ
BSC	8	8	3	0	0	0	0	0	19	≥19
ESC	12	15	0	0	0	0	0	0	27	≥27
HSC	3	0	0	0	0	0	0	3	6	≥06
PCC	0	0	20	24	23	20	7	0	94	≥75
DEC	0	0	0	0	0	0	9	12	21	≥15
OPC	0	0	0	0	0	3	3	0	6	6
PRC	0	0	0	0	0	0	2	4	6	6
EAA	0	0	0	0	0	0	0	0	0	0
	23	23	23	24	23	23	21	19	179	173

DEPATMENTAL ELECTIVES

IV Year I semester

Course Code	Elective – 1, 2, 3
CE411	Industrial Waste Treatment
CE412	Air Pollution
CE413	Prestressed Concrete
CE414	Applied Stress Analysis
CE415	Foundation Analysis and Design
CE416	Ground Improvement Techniques
CE417	Advanced Surveying
CE418	Travel Demand Analysis
CE419	Traffic Engineering and Design
CE420	Systems Analysis in Civil Engineering
CE421	Irrigation Management
CE422	Design of Hydraulic Structures

IV Year II semester

Course Code	Elective – 4, 5, 6, 7
CE461	Environmental Modelling
CE462	Environmental Impact Assessment
CE463	Solid Waste Management
CE464	Design of Earthquake Resistant Structures
CE465	Advanced Reinforced Concrete Design
CE466	Repair and Rehabilitation of Structures
CE467	Finite Element Analysis
CE468	Earthquake Geotechnical Engineering
CE469	Applications of Geosynthetics
CE470	Rock Engineering and Under Ground Structures
CE471	Global Navigation Satellite System
CE472	Geographical Information System
CE473	Highway Construction and Maintenance
CE474	Non Motorized Transport
CE475	Computational Hydraulics
CE476	Water Resources Systems
CE477	Hydro Power Engineering
CE478	Watershed Management

List of Open Electives

(Offered to Other Department Students)

III Year: II Semester

Course Code	Open Elective -1
CE390	Environmental Impact Analysis

IV Year: I Semester

Course Code	Open Elective -2
CE440	Building Technology

Mandatory Audit Course (Self Study)

Student is required to complete at least one course offered by the following agencies. The student is required to take prior approval from the Department, before registering for any course. The student can register for such a course either in 6th Semester or 7th semester. Unless the student submits a pass certificate, he/she shall not be eligible for the award of degree.

ASCE: American Society of Civil Engineer Certification Program – www.asce.org

SWAYAM: www.swayam.gov.in

NPTEL: www.onlinecourse.nptel.ac.in

Course Era: www.coursera.org

Free Online Courses: www.edx.org

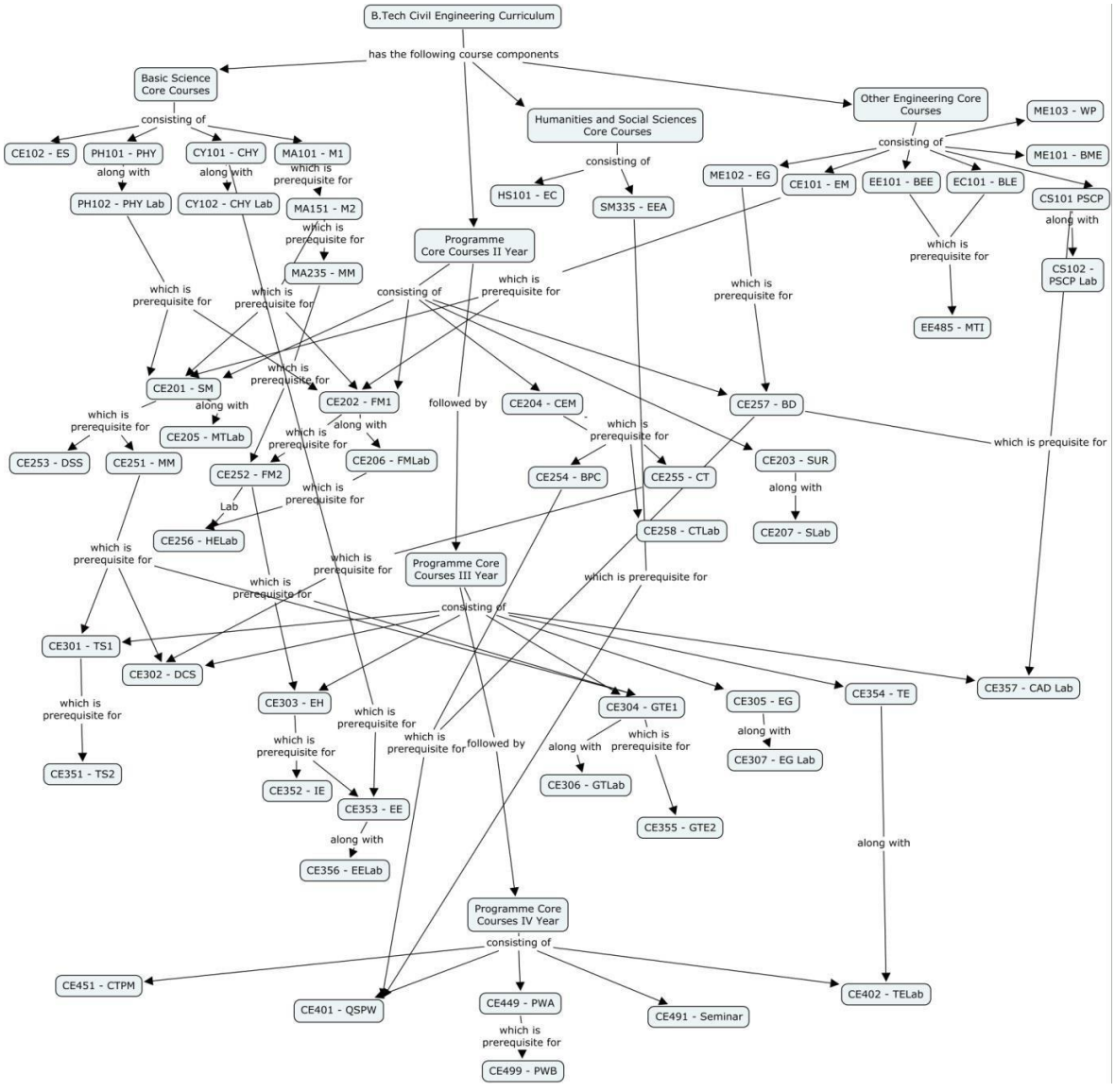
MIT Open Course ware: www.ocw.mit.edu

Points to be noted:

1. Definition of Pre-requisite: The student should have studied that subject which is mentioned as Pre-requisite.
2. Course with same name but with different code number indicates that the subject pertains to different departments and also the syllabus is different.
3. EPICS (Engineering Project in Community Service) Project is offered in two parts as Part-A in III Year II Semester and Part-B in IV Year I semester, with Two credits each. The credits earned are not counted for Computation of SGPA and CGPA. The course is not mandatory. It is Optional. Interested students can take it.
4. In first year syllabus, Engineering Biology is included in Physics cycle and Basic Mechanical Engineering is included in Chemistry cycle. This is with effect from 2018-2019 onwards.

B.TECH IN CIVIL ENGINEERING

PRE-REQUISITE CHART



DETAILED SYLLABUS

MA101	MATHEMATICS – I	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Solve the consistent system of linear equations
CO2	Apply orthogonal and congruent transformations to a quadratic form
CO3	Determine the power series expansion of a given function
CO4	Find the maxima and minima of multivariable functions
CO5	Solve arbitrary order linear differential equations with constant coefficients
CO6	Apply the concepts in solving physical problems arising in engineering

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	2	1										2	1
CO2	3	3	1	2	1										2	1
CO3	3	3	1	2	1										2	1
CO4	3	3	1	2	1										2	1
CO5	3	3	1	2	1										2	1
CO6	3	3	1	3	1										3	2

Detailed Syllabus:

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansions; Asymptotes; Curvature; Curve tracing; Functions of several variables - partial differentiation; total differentiation; Euler's theorem and generalization; Change of variables - Jacobians; maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers.

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE $y' = f(x, y)$; Exact differential equations; integrating factors; orthogonal trajectories; Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, Fifth Edition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Eighth Edition, 2015.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

HS101	ENGLISH FOR TECHNICAL COMMUNICATION	HSC	2-0-2	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to:

CO1	Understand and learn the nuances of paragraph writing and sample different types of paragraphs that are commonly used; learn to write an effective paragraph using devices of coherence and cohesion; Understand the meaning of idioms and phrasal verbs and use them in context; learn to use sentences unambiguously.
CO2	Learn to construct an effective résumé and cover letter ; learn the finer points and dos and don'ts of résumé writing
CO3	Master the skills and sub skills of reading ; use strategies for reading effectively: skimming, scanning, mapping; Learn to analyze vocabulary through contextual clues, word parts, analogies; demonstrate the ability to employ a range of critical reading skills
CO4	Learn the importance and use of reported speech in a wide range of contexts; use active and passive voice in engineering and scientific contexts when compiling lab reports, project reports, writing technical papers, etc.
CO5	Learn the structure and format of technical reports; distinguish technical reports from other types of reports such as business reports, analytical reports, progress reports, etc. learn to write technical reports on a variety of topics
CO6	Learn to interpret graphs of various kinds and pie charts and diagrams; learn to use terms of comparison and contrast when interpreting charts, bar diagrams and graphs

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						1				3		1				

CO2						1				3		1				
CO3						1				3		1				
CO4						1				3		1				
CO5						1				3		1				
CO6						1				3		1				

Detailed Syllabus:

1. **Grammar Principles** (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts
2. **Effective Sentence Construction** - strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity
3. **Reported speech** - contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English
4. **Paragraph-writing**: Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.
5. **Note-making** - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.
6. **Letter-Writing**: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises
7. **Reading techniques**: Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises.
8. **Reading Comprehension** - reading silently and with understanding- process of comprehension- types of comprehension questions.
9. **Features of Technical English** - description of technical objects and process- Report-Writing- definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports-examples and exercises
10. **Book Reviews** - Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used

Language laboratory

1. **English Sound System** -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises
2. **Stress and Intonation** –word and sentence stress - their role and importance in spoken English-Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.-use of intonation in daily life–exercises
3. Introducing oneself in formal and social contexts- Role plays- their uses in developing fluency and communication in general.
4. **Oral presentation** - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.

5. **Listening Comprehension** -Challenges in listening, good listening traits, some standard listening tests- practice and exercises.
6. **Debate/ Group Discussions** - concepts, types, Do's and don'ts- intensive practice.

Reading:

1. English for Engineers and Technologists (Combined Edition, Vol. 1 and 2), Orient Blackswan, 2006.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006.
3. Meenakshi Raman and Sangeetha Sharma, Technical Communication: Principles and Practice Second Edition, Oxford University Press, 2011.

Software:

1. Clear Pronunciation – Part-1 *Learn to Speak English.*
2. Clear Pronunciation – Part-2 *Speak Clearly with Confidence*
3. Study Skills
4. English Pronunciation

PH101	PHYSICS	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to:

CO1	Solve engineering problems using the concepts of wave and particle nature of radiant energy.
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Understand the nature and characteristics of new Materials for engineering applications.
CO4	Apply the concepts of light propagation in optical fibers, light wave communication systems, holography and for sensing physical parameters.
CO5	Apply the knowledge of Solar PV cells for choice of materials in efficient alternate energy generation.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1									1	1	1	
CO2	3	3	1	1										2		
CO3	3	3	1	1									1	3	2	
CO4	3	3	1	`1									2			1
CO5	3	3	1	1										1		

Detailed Syllabus:

Quantum Mechanics: Concepts and Experiments that led to the discovery of Quantum Nature. Heisenberg uncertainty principle; Schrodinger time independent and time dependent wave equations, The free particle problem - Particle in an infinite and finite potential well, Quantum mechanical tunneling. MB, BE and FD distributions.

Wave and Quantum Optics:

Interference and Diffraction: Concept of interference and working of Fabry-perot Interferometer and its application as wavelength filter. Multiple beam diffraction and Working of diffraction Gratings, Application of Grating as wavelength splitter.

Polarization Devices: Principles, Working and applications of Wave Plates, Half Shade Polarimeter, Polariscope, Isolators and Liquid Crystal Displays.

Lasers: Basic theory of Laser, Concept of population inversion and Construction and working of He-Ne, Nd-YAG, CO_2 Lasers, LED, White light LED, Semiconductor Laser, Holography and NDT.

Optical Fibers: Structure, Types, Features, Light guiding mechanism and applications in Communications and Sensing.

Solar Cells: Solar spectrum, photovoltaic effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, applications.

Magnetic and Dielectric Materials:

Magnetic Materials and Superconductors: Introduction - Weiss Theory of Ferromagnetism – Properties – Domains – Curie Transition - Hard and soft magnetic materials – Spinel Ferrites – Structure – Classification – Applications - Meissner effect - Type-I and Type-II Superconductors – Applications.

Dielectric Materials: Introduction to Dielectrics, Dielectric constant – Polarizability - Properties and types of insulating materials **-** Polarization mechanisms in dielectrics(Qualitative) – Frequency and temperature dependence of polarization – Dielectric loss Clausius-Mossotti Equation(Qualitative)– dielectric Breakdown – Applications.

Functional and Nano Materials:

Functional Materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, Bio-materials, high temperature materials and smart materials - Properties and applications.

Nanomaterials: Introduction, classification, properties, different methods of preparation and applications.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, John Wiley, Nineth Edition, 2011.
2. Beiser A, Concepts of Modern Physics, McGraw Hill International, Fifth Edition, 2003.
3. Ajoy Ghatak, Optics, Tata McGraw Hill, Fifth Edition, 2012.
4. S.O.Pillai, Solid State Physics, New Age Publishers, 2015.

EC101	BASIC ELECTRONIC ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers
CO2	Understand the principles of working of amplifiers
CO3	Understand and design of simple combinational and basics of sequential logic circuits
CO4	Understand the principles of electronic measuring instruments and Transducers
CO5	Understand the basic principles of electronic communication

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1			1										
CO2	3	3	1			1										
CO3	3	3	1			1										
CO4	3	3	1			1										
CO5	3	3	1			1										

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive Feedback, merits and demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's), Introduction to microprocessors and microcontrollers.

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CRO's).

Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain guage and thermocouples. Introduction to data acquisition system.

Principles of Communication: Need for Modulation, Definitions of various Modulation and Demodulation techniques, AM radio transmitter and receiver, brief understanding of FM and mobile communications.

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, Tata McGraw Hill, Second Edition, 2013.
2. Malvino and Brown, Digital Computer electronics, McGraw Hill, Third Edition, 1993.
3. Keneddy and Davis, Electronic Communication Systems, McGraw Hill, Fourth Edition, 1999.
4. Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall India, 2011.
5. Salivahanan, N Suresh Kumar, Electronic Devices and circuits, McGraw Hill publications, Third Edition, 2012.
6. Neil Storey, Electronics A Systems Approach, Pearson Education Publishing Company Pvt. Ltd, Fourth Edition, 2009.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	2-0-0	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to:

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyze material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3			2	3	1					1	1	2	2
CO2	3	3	3			2	3	1					2		2	1
CO3	3	3	3			2	3	1					2	1	1	1
CO4	3	3	3			2	3	1					2		1	2
CO5	3	3	3			2	3	1					1			3

Detailed Syllabus:

Introduction to Environmental Science: Environment and society, major environmental issues: Ozone layer depletion, Acid rains, global climate change etc, sustainable development, Environmental impact assessment, environmental management

Natural Resources Utilization and its Impacts: Energy, minerals, water and land resources, Resource consumption, population dynamics, urbanization.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: Sources, types of pollutants and their effects, water quality issues, contaminant transport, self-purification capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Sources, classification and their effects, Air quality standards, dispersion of pollutants, control of air pollution, automobile pollution and its control.

Solid Waste Management: Sources and characteristics of solid waste, effects, Collection and transfer system, disposal methods

Reading:

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt Ltd, Special Indian Edition, 2007.
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, Eighth Edition, 2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers, 2009.

BT101	ENGINEERING BIOLOGY	ESC	2 – 0 – 0	2 Credits

Pre-requisites: None

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

CO1	Realize the significance of biomolecules for sustaining life
CO2	Identify the difference between unicellular to multi-cellular organisms
CO3	Understand heredity, variation and central dogma of life
CO4	Analyze and understand the concepts of biology for engineering the cell

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	3	1												
CO2	2	3	3	1												
CO3	2	3	3	1												

CO4	2	3	3	1												

Detailed Syllabus:

Molecules of life, water and carbon - chemical basis of life, protein structure and function, nucleic acids and the RNA world, carbohydrates, lipids, membranes and first cells.

Cell structure and function, inside the cell, cell–cell Interactions, cellular respiration and fermentation, photosynthesis, cell cycle, biological signal transduction.

Gene structure and expression, Mitosis, Meiosis, Mendel and the gene, DNA and the gene: synthesis and repair, how genes work, transcription, RNA processing, and translation, control of gene expression, analyzing and engineering genes, genomics.

Engineering concepts in biology – genetic engineering, disease biology and biopharmaceuticals, stem cell engineering, metabolic engineering, synthetic biology, neuro transmission, biosafety and bioethics.

Reading:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016.
2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017.

CS101	**PROBLEM SOLVING AND COMPUTER PROGRAMMING**	**ESC**	**3 –1–2**	**5 Credits**

Pre-requisites: None.

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

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object oriented features in developing programs to solve real world problems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	2	3											
CO2	3	2	3	2	3											
CO3	3	2	3	2	3											

CO4	3	2	3	2	3											
CO5	3	2	3	2	3											
CO6	3	2	3	2	3								1	1	1	1

Detailed Syllabus:

Theory:

Fundamentals of Computers, Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation, Basics of C++, Basic data types, Numbers, Digit separation, Reverse order, Writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs, Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions – Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion, Introduction to pointers.

Sorting and searching algorithms, large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions

Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays

String processing, File operations.

Structures and Classes - Declaration, member variables, member functions, access modifiers, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Laboratory:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (integer pointers, character pointers).
6. Programs on structures.
7. Programs on classes and objects.

Reading:

1. Walter Savitch, Problem Solving with C++, Pearson, Nineth Edition, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, Second Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

PH102	PHYSICS LABORATORY	BSC	0 –1–2	2 Credits

Pre-requisites: None

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

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2		3					3	2						
CO2	3	2		3					3	2						
CO3	3	2		3					3	2						
CO4	3	2		3					3	2						

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

MA 151	MATHEMATICS – II	BSC	3-0-0	3 Credits

Pre-requisites: MA101: Mathematics-I

Course Outcomes: At the end of the course, the students will be able to:

CO 1	Analyze improper integrals
CO 2	Evaluate multiple integrals in various coordinate systems
CO 3	Apply the concepts of gradient, divergence and curl to formulate engineering problems
CO 4	Convert line integrals into surface integrals and surface integrals into volume integrals
CO 5	Apply Laplace transforms to solve physical problems arising in engineering

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	2	1										2	1
CO2	3	3	1	2	1										2	1
CO3	3	3	1	2	1								1		2	1
CO4	3	3	1	2	1										2	1
CO5	3	3	1	2	1										2	1

Detailed Syllabus:

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentiation under integral sign; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals.

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stoke's theorem; Gauss Divergence theorem.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; **Convolution theorem**; Applications of Laplace transforms - solving certain initial value problems, solving system of linear differential equations, finding responses of systems to various inputs viz. sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, Narosa Publishing House, 5thEdition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8thEdition, 2015.

3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

ME102	ENGINEERING GRAPHICS	ESC	1-1-4	4 Credits

Pre-requisites: None

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

CO1	Apply BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyse the internal details of an object through sectional views.
CO5	Develop 3D Isometric View in relation with 2D orthographic views
CO6	Construct 2D (orthographic) and 3D (isometric) views in CAD environment.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	2		1				1	2			1		1	
CO2	2	2	2		1				1	2			1		1	
CO3	2	2	2		1				1	2			2		2	
CO4	2	2	2		1				1	2			2		2	
CO5	2	2	2		1				1	2			2		2	
CO6	2	2	2		1				1	2			2		2	

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales

Orthographic Projection: Principles of Orthographic projection, Four Systems of Orthographic Projection.

Projection of Points: Projections of points when they are situated in different quadrants.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.
Auto-CAD Practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES

Reading:
1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23rd Edition, 2016.

CY101	CHEMISTRY	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to:

CO1	The basic knowledge of the organic reaction mechanism and intermediates.
CO2	The basic knowledge of methods of chemical structure analysis and the instrumentation involved.
CO3	The potential energy aspects of fuel cells, rechargeable batteries and new materials for their fabrication.
CO4	About optical fibres, liquid crystals, LCD, LED, OLED, conducting polymers and their applications.
CO5	The quantum and thermodynamic aspects of various types of bonding, coordination complexes and chemical and enzymatic reactions.
CO6	The synthetic methodologies, importance and applications of nanomaterials in different fields.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3		2		2		2					1		
CO2	3	3	3		2		2		2					2		
CO3	3	3	3		2		2		2					2		
CO4	3	3	3		2		2		2					2		
CO5	3	3	3		2		2		2					2	1	
CO6	3	3	3		2		2		2					2	1	

Detailed syllabus:
Quantum Chemistry and Chemical Bonding: Emergence of Quantum Theory; Postulates of Quantum Mechanics, Operators and Observables, Schrodinger Equation, Particle in a One-Dimensional Box and Colour of Conjugate Molecules, Hetero-diatomic Molecule as Harmonic

Oscillator and Rigid Rotor, Hydrogen Atom, LCAO-MO Theory (MO Diagram of CO and NO Molecules).

Chemical Thermodynamics, Equilibrium and Kinetics: Enthalpy and Free Energy Changes in Chemical Reactions; Relevance of C_p and C_v in Gas Phase Reactions, Chemical Potential; Heat Capacity of Solids, Absolute Entropy and Third Law of Thermodynamics, Rates of Enzyme-Catalyzed Homogeneous and Heterogeneous Surface-Catalyzed Chemical Reactions

Electrochemistry and Chemistry of Energy Systems: Electrodes and Electrochemical Cells; Potentiometric and Amperometric Sensors; Li-Ion and Ni-Cd Rechargeable Batteries; Fuel Cells (Methanol-Oxygen); Electrochemical Theory of Corrosion; Factors Affecting Rate of Corrosion; Sacrificial Anodic and Impressed Current Cathodic Protection of corrosion.

Coordination Chemistry and Organometallics: Shapes of Inorganic Compounds; Crystal Field and Molecular Orbital Theories; MO-Diagram for an Octahedral Complex; Metal Ions in Biology; Organometallic Chemistry (Metal Carbonyls).

Basics of Organic Chemistry: Classification of Organic reaction and their mechanisms. Reaction intermediates: formation, structure and properties. Named Reactions: Skraup's synthesis, Diels-Alder reaction, Click Reactions.

Engineering Materials and Application: Introduction to Optical fibres, types of optical fibres, applications of optical fibres. Liquid Crystals: LCD, LED, OLED, Conducting Polymers and applications.

Instrumental Methods of Chemical Analysis: Gas- and Liquid-Chromatographic Separation of Components of Mixtures; UV-Visible, FTIR, NMR and Mass Spectral Methods of Analysis of Structures of Organic Compounds.

Reading:

1. P. Atkins and Julio de Paula, Physical Chemistry, Freeman & Co. 8th Edition, 2017.
2. Atkins and Shriver, Inorganic Chemistry, Oxford University Press, 4th edition, 2008.
3. Clayden, Greaves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2014.
4. Shashi Chawla, Engineering Chemistry, Dhanpat Rai & Co. 2017.
5. Paula Bruce, Organic Chemistry, Pearson, 8th Edition, 2013.

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to:

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities and requirements of illumination

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2				1									
CO2	3	3	2				1									
CO3	3	3	2				1									
CO4	3	3	2				1									

Detailed Syllabus:

DC Circuits: Kirchoff's Voltage and Current Laws, Superposition Theorem, Star-Delta Transformations

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of 1-ϕ Series & Parallel Circuits, Solution of 3-ϕ circuits and Measurement of Power in 3-ϕ circuits

Magnetic Circuits: Fundamentals and solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equation, Phasor Diagram, Equivalent Circuit of a 1-ϕ Transformer, Determination of Equivalent circuit parameters, calculation of Regulation & Efficiency of a Transformer

DC Machines: Principle of Operation, Classification, EMF and Torque Equations, Characteristics of Generators and Motors, Speed Control Methods and Applications

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-ϕ Induction Motor, Torque – Speed Characteristics of 3-ϕ Induction Motor, Applications

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters

Illumination: Laws of illumination and luminance.

Reading:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12th Edition, 2016.
2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2nd Edition, 2015.
3. V N Mittle and Arvind Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2005.
4. E. Openshaw Taylor, Utilization of Electrical Energy, Orient Longman, 2010.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 - 0 - 0	3 Credits

Pre-requisites: None

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

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	Understand the concepts of thermodynamics and functions of components of a power plant.
CO5	Understand basics of heat transfer, refrigeration, internal combustion engines and Automobile Engineering.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	1		1	1							3		
CO2	3	3	3	1	3	1	1							1	1	
CO3	3	3	3	1		1	1								1	1
CO4	3	3	3	1		1	1								2	
CO5	3	3	3	1		1	1								1	

Detailed Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties

Manufacturing Processes: Castings – Patterns & Moulding, Hot Working and Cold Working, **Metal Forming processes**: Extrusion, Drawing, Rolling, Forging, Welding – Arc Welding & Gas Welding, Soldering, Brazing.

Machine Tools: Lathe – Types – Operations, Problems on Machining Time Calculations, Drilling M/c – Types – Operations, Milling M/c – Types – Operations – Up & Down Milling, Shaping M/c – Operations–Quick Return Mechanism, Planer M/c.– Operations–Shaper Vs Planer, Grinding M/c– Operations. Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains –Simple Problems

Fasteners and Bearings: Fasteners – Types and Applications, Bearings – Types and Selection,

Thermodynamics: Energy Sources – Conventional/Renewable, Thermodynamics – System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law – Cyclic process, Change of State, C_p, C_v, Limitations of First law, Thermal

Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/CoP, Second law, PMM2, Carnot Cycle, Entropy – T-s and P-v diagrams.

Thermal Power Plant: Layout of Thermal Power Plant & Four circuits – Rankine cycle, T-s & P-v diagrams, Boilers – Babcock & Wilcox, Cochran Boilers, Comparison of Fire Tube &Water Tube Boilers, Steam Turbines – Impulse Vs. Reaction, Compounding – Pressure & Velocity Compounding, Condensers – Jet Condenser and Surface Condenser; Cooling Towers.

I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences

Refrigeration: Vapor Compression Refrigeration Cycle – Refrigerants, Desirable Properties of Refrigerants

Heat Transfer: Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal Expanding Shoe Brake

Reading:

1. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2008.
2. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
3. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
4. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, Nem Chand Brothers, New Delhi, 1994.
5. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

CE101	ENGINEERING MECHANICS	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2			1									3	
CO2	3	3	2			1									3	
CO3	3	3	2			1									3	
CO4	3	3	2			1								1	2	

CO5	3	3	2			1								1	2	

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Free body diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components.

Reading:

1. J.L.Meriam, L.G. Kraige, Engineering Mechanics, John Wiley &Sons,7th Edition, 2012.
2. Timoshenko, Young, Engineering Mechanics, McGraw Hill Publishers,3rd Edition, 2006.
3. Gere, Timoshenko, Mechanics of Materials, CBS Publishers, 2nd Edition, 2011.

ME103	**WORKSHOP PRACTICE**	**ESC**	**0 - 0 – 3**	**2 Credits**

Pre-requisites: None

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

CO1	Study and practice on power tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1			1			2	2				1		
CO2	3	3	1			1			2	2				1		
CO3	3	3	1			1			2	2				1		
CO4	3	3	1			1			2	2				1		

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper. Demonstration of the working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, half lap Dovetail joint and Mortise Tenon Joint.

CY102	CHEMISTRY LABORATORY	BSC	0- 1 – 2	2 Credits

Pre-requisites: None

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

CO1	Select a suitable methodology and compare the strategies involved in the estimation of metal content, iodine content, active chlorine or hardness of water for various applications.
CO2	Apply a selective instrumental method in the place of tedious and complex titration processes for repeated and regulated analysis of acids, bases, redox compounds, etc.
CO3	Test and validate optical activity, corrosion inhibitor efficiency and absorption isotherm of selective compounds and processes.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	-	2	-	2		2	-	-	-		2		
CO2	3	3	3	-	2	-	2		2	-	-	-		2		
CO3	3	3	3	-	2	-	2		2	-	-	-		2		

Detailed Syllabus:

Cycle-I

1. Standardization $KMnO_4$ solution: Understanding the redox process, electron transfer, importance of qualitative and quantitative analysis.
2. Estimation of Hematite: Understanding the importance on purity of a ore, % of metal content (for Fe).
3. Hardness of Water: Understanding the metal complexes, multi dentate ligands, importance of purity of ground water, (EDTA method; complexometry).
4. Analysis of bleaching powder for available chlorine: Understanding the importance and purity of potable water, back titration (Iodometry).
5. Preparation of nanomaterials: Understanding the importance of nanomaterials, their preparation and characterization.

Cycle-II

1. pH metry: Concept of pH, Instrumentation, calibration, determination of the concentrations by instrumental methods
2. Conductometry: Concept of conductivity, importance of conductivity
3. Potentiometry: Determination of the redox potential of the reaction
4. Colorimetry: Importance of Beers and Lamberts law,
5. Photochemical experiment: Importance of visible light and its application for a redox process, importance of coloring agent
6. Preparation of bakelite / polypyrrole: Concepts of organic reactions and application for the organic material preparation.
7. Corrosion experiment: Concept of corrosion, importance of corrosion agents
8. Adsorption experiment: Understanding phenomena of adsorption and absorption
9. Analysis of a drug: Importance of the purity, concentrations of a drug molecule.
10. Preparation of bakelite / red azo dye / Aspirin / Fe(acac) / polypyrrole: Concepts of organic reactions and application for the organic material preparation

Reading:

1. Charles Corwin, Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Pearson Education, 2012.
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 1st Edition, 2006.

MA211	MATHEMATICAL METHODS	BSC	3-0-0	3 Credits

Pre-requisites: MA101-Mathematics - I and MA151-Mathematics - II

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

CO1	Determine Fourier series expansion of a given function
CO2	Solve PDEs by variables separable method
CO3	Test the hypothesis for large and small samples
CO4	Solve numerically algebraic/transcendental and ordinary differential equations

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	1	-	-	-	-	-	-	1	-	-	-	1
CO2	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-	1
CO3	2	2	1	1	1	-	-	-	-	-	-	1	-	-	-	1
CO4	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-	1

Detailed Syllabus:

1. Fourier series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions.
2. Partial Differential Equations: PDE types, method of separation of variables - solution of Heat equation
3. Complex Variables: Analytic function - Cauchy Riemann equations, Conformal mapping
4. Probability and Statistics: Random variables, Discrete and continues distributions, mean and variance\, Binomial, Poisson and Normal distributions, Testing of Hypothesis - Z-test for single mean and difference of means - t-test for single mean and difference of means, F-test for comparison of variances,. Chi-square test for goodness of fit. – Kari Pearson coefficient of correlation – lines of regression.
5. Numerical Analysis: Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Rapson's method – Finite Differences - Newton's Forward, backward difference interpolation formulae - Lagrange interpolation - Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule - solving first order differential equations –Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method of 4^{th} order.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Publ., 2016.
2. B.S.Grewal, Higher Engineering Mathematics, Khannna Publishers, 2017
3. S.C.Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Co, 2006

CE201	STRENGTH OF MATERIALS	PCC	3-1-2	5 Credits

Pre-requisites: CE101-Engineering Mechanics

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

CO1	Analyse the statically determinate and indeterminate problems
CO2	Determine the stresses and strains in the members subjected to axial, bending and torsional loads
CO3	Evaluate the slope and deflection of beams subjected to loads
CO4	Determine the principal stresses and strains in structural members

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	1	-	-	1	-	1	1	-	-	-	-	3	1	1
CO2	2	3	1	1	-	1	-	1	1	-	-	-	-	3	1	1
CO3	1	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1
CO4	1	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1

Detailed Syllabus:

1. Stress And Strain: Concept of statical determinacy and indeterminacy- Determinate and Indeterminate problems in Tension and Compression - Thermal Stresses.
2. Elastic Constants and Impact Loading: Stress-strain diagrams for brittle and ductile materials -working stress - Strain energy in tension and compression - Impact loading - pure shear - Modulus of rigidity and Bulk modulus - Relation between E, G and K.
3. Shear Force And Bending Moment: Types of supports - Types of determinate beams - Simply supported, Cantilever, Overhanging and compound beams with articulations -Shear Force and Bending Moment diagrams - Principles of Superposition.
4. Thin Cylinders & Thin spherical shells: Internal fluid pressure – Wire wound thin cylinders.
5. Theory of Simple Bending: Assumptions - Theory of Simple Bending - Bending stresses in beams - Discussion of efficiency of various shapes of cross sections - Flitched beams.
6. Deflection of Beams: Double Integration method, Macaulay's method, Moment area method, Conjugate Beam method - Calculation of Slope and deflections of statically determinate beams.
7. Shear Stress Distribution: Flexural shear stress distribution in various shapes of cross section of beams.
8. Torsion Of Circular Shafts: Theory of Pure Torsion in Solid and Hollow circular shafts - Torsional Shear Stresses and angle of twist - transmission of Power.

Reading:

1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.
2. T.D.Gunneswra Rao and Mudimby Andal, Strength of Materials - Fundamentals and Applications, Cambridge University Press, 1st Edition, 2018 .

3. Beer and Johnston, Mechanics of Materials, McGraw Hill International Edition, 1995.
4. E.P.Popov, Engineering Mechanics of Solids, Prentice Hall of India Pvt. Ltd., 1998.

MATERIAL TESTING LABORATORY

1. To study the stress -strain characteristics of (a) Mild Steel and (b) Tor steel by conducting tension test on U.T.M.
2. To study the stress - strain characteristics of (a) Copper and (b) Aluminium by conducting tension test on Hounsfield Tensometer.
3. To find the Compressive strength of wood and punching shear strength of G.I. sheet by conducting relevent tests on Hounsfield Tensometer.
4. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper by conducting hardness test.
5. To determine the Modulus of rigidity by conducting Torsion test on (a) Solid shafts (b) Hollow shaft.
6. To find the Modulus of rigidity of the material of a spring by conducting Compression test.
7. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
8. To determine the Modulus of elasticity of the material by conducting deflection test on a Propped Cantilever beam.
9. To determine the Modulus of elasticity of the material by conducting deflection test on a continuous beam.
10. Ductility test for steel.
11. Shear test on Mild Steel rods.

Reading:

1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.

CE202	FLUID MECHANICS-I	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Compute hydrostatic forces acting on submerged surfaces
CO2	Apply conservation laws to solve steady state fluid flow problems
CO3	Apply the basic laws of mechanics in the fields of hydrology, irrigation engineering and hydraulic structures
CO4	Analyse the characteristics of flow through pipes
CO5	Design simple pipe systems
CO6	Apply the principles of dimensional analysis for design of experiments

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	1	-	-	-	-	-	-	-	1	-	-	3	-
CO2	3	3	2	1	-	-	-	-	-	-	-	1	-	-	3	-
CO3	3	3	3	2	-	-	-	-	-	-	-	1	-	-	3	-
CO4	3	3	2	2	-	-	-	-	-	-	-	1	-	-	3	-
CO5	3	2	3	2	-	-	-	-	-	-	-	1	-	-	3	-
CO6	3	3	3	3	2	-	-	-	-	-	-	1	-	-	3	-

Detailed Syllabus:

1. Introduction: Purpose of study of fluid mechanics for design and operation of engineering systems in the fields of Mechanical Engineering, Aeronautical Engineering, Metallurgical Engineering, Civil Engineering, Biomedical Engineering, Chemical Engineering, Fundamental difference between a solid and a fluid, constituent relationships for solids and fluids, conservation principles applied in fluid mechanics.
2. Properties of fluids, concept of continuum, viscosity, compressibility, ideal and real fluids, surface tension, cavitation.
3. Stress at a point, pressure, Pascal's law, Variation of pressure with elevation in compressible and incompressible fluids, hydrostatic law, Pressure measurement, piezometers and manometers Hydrostatic forces exerted on submerged surfaces.
4. Description of fluid flow: with reference to translation, rotation and deformation, concept of continuum, control mass & control volume approach, Reynolds transport theorem. Steady flow and uniform flow.
5. Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocity potential function, potential flow, standard flow patterns, combination of flow patterns, flownet analysis
6. Forces exerted in a fluid flow, derivation of Continuity equation and Euler's equation, Bernoulli's equation and its applications, Momentum equation and its applications
7. Dimensional Analysis as a tool in design of experiments, identification of non dimensional numbers and their significance, dimensional analysis methods
8. Measurement of flow in pipes and open channels, orifice, mouthpiece, orificemeter and venturimeter, weirs and notches
9. Laminar flow and its characteristics, Navier-Stokes equations - exact solutions, Laminar flow between parallel plates, Laminar flow through pipes, Hazen-Poiseuille equation, Reynolds experiment, head loss in flow through pipes, Darcy Weisbach equation, losses in pipe transitions, Turbulence, Reynolds turbulent stresses, Prandtl's mixing length theory, Velocity distribution in turbulent flow, pipe networks.

Reading:

1. F M White, Fluid Mechanics, Tata McGraw Hill Publication 2011.
2. Robert W. Fox, Philip J. Pritchard, Alan T. McDonald, Introduction to Fluid Mechanics, Student Edition Seventh, Wiley India Edition, 2011.

3. Shames, Mechanics of Fluids, McGraw Hill Book Co., New Delhi, 1988.
4. Streeter V.L., Benjamin Wylie, Fluid Mechanics, McGraw Hill Book Co., New Delhi, 1999.

CE203	SURVEYING	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Learn the basic principles of Surveying
CO2	Know different instruments and techniques to determine the positions on the surface of the earth
CO3	Prepare maps/plans from the collected field data
CO4	Understand the techniques for setting out curves and other layouts etc
CO5	Familiar with the basic surveying techniques to be used for a specific civil engineering project

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	2	1	3	3	3	3	1	1	1	1	-	3	-
CO2	3	2	3	3	2	2	2	1	1	2	3	2	1	-	2	-
CO3	3	1	2	1	1	3	1	1	2	3	2	2	2	2	2	2
CO4	3	3	2	2	3	2	3	2	3	2	3	2	2	-	2	1
CO5	3	2	2	3	3	3	3	3	3	2	3	2	3	-	2	3

Detailed Syllabus:

1. Introduction: Surveying objectives, plane surveying principles and classification, scales, Errors and Mistakes
2. Chain Surveying: Principles, Equipment, Types of tapes and chains, selection of stations, offsets, Tape Variations, Errors and Corrections
3. Compass Surveying: Measurement of directions and angles, types of compass, meridians and bearings, local attraction, magnetic declination, traversing, plotting of traverse, adjustment of closing error
4. Plane Table Surveying: Principle and instruments used in plane table surveying, working operations, methods of plane table surveying
5. Levelling and Contouring: Description of a point (position) on the earth's surface, instruments for leveling, principle and classification of leveling, bench marks, leveling staff, readings and booking of levels, field work, longitudinal section and cross section, plotting the profile, height (level) computations, contours, characteristics of contours, methods of contouring, interpolation, contour gradient, contour maps
6. Areas and Volumes: Computation of areas from plans, calculation of areas of a closed traverse, measurements from cross section, calculation of volumes from spot levels, earth work calculations, practical problems

7. Theodolite and Tacheometric Surveying: Principle of theodolite survey, Theodolite component parts, observations, Traversing, traverse computations, Trigonometrical Surveying, Tacheometry, principle of tacheometry, methods of tacheometry, tacheometry as applied to subtense measurement
8. Curve Settting: Types of curves, elements of a curve, setting out a simple curve, setting out a compound curve, checks on field work, reverse curve, transition curves, super elevation, deflection angles, transition curves, characteristics of transition curves, method of setting out a compound curve, types of vertical curves, setting out vertical curves
9. Advanced Surveying: Principle of EDM, Features and Functions of Total Station, Global Positioning System – Segments, Positioning methods, Errors, Applications
10. Introduction To Photogrammetry: Geometric Concepts, Analysis of the single photograph, Relief Displacement, Parallax, Stereoscopy, Photogrammetric Products, Introduction to UAV systems

Reading:

1. B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2005
2. Chandra A. M., Higher Surveying, New Age International Publishers, 2007
3. Chandra A. M., Plane Surveying, New Age International Publ., 2007
4. James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012
5. Charles D Ghilani, Paul R Wolf., Elementary Surveying, Prentice Hall, 2012

CE204	CIVIL ENGINEERING MATERIALS	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Classify and characterize stones
CO2	Comprehend the manufacturing process of bricks, lime and cement
CO3	Recognize the preservation methods of timber and metals
CO4	Understand the use of non-conventional Civil Engineering materials

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	-	-	-	-	2	-	1	2	2	3	2	3	2	1	-
CO2	2	2	2	-	-	2	2	2	2	2	2	2	-	3	1	-
CO3	1	2	1	2	1	2	2	2	2	2	2	3	2	2	1	-
CO4	2	3	2	2	3	3	2	1	2	2	3	3	-	3	1	-

Detailed Syllabus:

1. Building Stones: Classification of stones- Characteristics of good building stones, important types of building stones, their properties and stones and uses.

2. Brick and other Clay Products: Composition of brick-earth, manufacturing process of bricks, characteristics of good building bricks, classification and testing of bricks, special types of bricks and their uses. Types of tiles and their use in buildings. Terracotta, stoneware
3. Lime and Cement: IS classification of lime and uses, flow diagram of manufacturing process of cements, chemical composition of cement, IS specifications and tests on Portland cement, different types of cements and their uses.
4. Mortar and Concrete: Preparation of cement mortar and concrete, proportion of mortars and concrete for different types of works, properties of concrete in plastic and hardened stages, factors affecting strength of concrete, types of concrete and their specific use.
5. Timber and Wood Based Products: Classification of timber trees, cross section of exogenous tree, hard wood and soft wood, seasoning of timber, important types of timber and their uses, ply wood and its uses.
6. Steel and Aluminium: Types of steel-mild steel, high carbon steel, high strength steel-properties and uses, commercial forms of steel and their uses.
7. Introduction to Some New Materials: Ferro cement, super plasticizers, AAC Block, FAL-G brick, fly ash, plastics, paints, and geotextiles.

Reading:

1. Duggal, S.K, (2008), Building Materials, Third Revised Edition, New Age International (P) Limited Publishers.
2. Peter A. Claisse, (2016), Civil Engineering Materials, Butterworth-Heinemann (Imprint of Elsevier). Copyright © 2016 Elsevier Ltd.
3. Haimei Zhang, (2011), Building Materials in Civil Engineering, Woodhead Publishing Limited and Science Press.

CE205	REMOTE SENSING	PCC	2-0-0	2 Credits

Pre-requisites: None

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

CO1	Analyze the energy interaction with atmosphere and earth surface features
CO2	Identify the earth surface features and prepare the thematic maps
CO3	Select the type of remote sensing technique / data for required application
CO4	Apply the remote sensing principles in civil engineering practice

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	-	-	2	-	-	-	2	-	-	2	3	2	-	-
CO2	2	1	1	3	2	2	2	1	1	3	2	2	2	2	3	2
CO3	-	1	1	2	2	-	2	2	2	2	2	2	2	-	2	3
CO4	-	2	3	3	2	3	3	3	2	3	3	2	2	2	3	2

Detailed Syllabus:

1. Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Stages of

Remote Sensing, Advantages of Remote Sensing over conventional surveying methods.

2. Electromagnetic Spectrum: wavelength regions important to remote sensing, Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing.
3. Platforms and Sensors: Types of platforms, orbit types, Sun-synchronous and Geosynchronous, Passive and Active sensors, resolution concept
4. Earth resources and meteorological satellites - Characteristics - LANDSAT, SPOT, IRS, IKONOS, QUICK BIRD, CARTOSAT, INSAT and other Satellites.
5. Image interpretation: Data Products and Their Characteristics, Basic Elements of Visual Interpretation (Image and Terrain), Equipment for Visual Interpretation, Ground Truth, Ground Truth Equipment.
6. Image Processing - Digital Image Processing – Pre-processing – image enhancement techniques – multispectral image classification – Supervised and unsupervised.
7. Applications: Geosciences, Water Resources, Land use – Land cover, Transportation Engineering

Reading:

1. James B. Campbell, Randolph H. Wynne. Introduction to Remote Sensing – The Guilford Press, 2011.
2. Lillisand T.M and Kiefer R.W – " Remote sensing and image Interpretation"—John Wiley & Sons, 2008
3. Floyd F.Sabins, Remote Sensing: Principles and interpretation, W.H. Freeman and Company, 2007

CE206	FLUID MECHANICS LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Calibrate flow discharge measuring device used in pipes channels and tanks
CO2	Determine Fluid and flow properties
CO3	Characterize laminar and turbulent flows
CO4	Appreciate importance of design of experiments
CO5	Develop procedure for standardization of experiments

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	1	3	-	1	-	-	1	-	-	1	2	-	2	-
CO2	1	1	1	3	-	1	-	-	1	-	-	1	2	-	3	-
CO3	1	2	1	3	-	1	-	-	1	-	-	1	2	-	3	-
CO4	1	2	2	3	-	1	-	-	1	-	-	1	1	-	1	-
CO5	1	2	2	3	-	1	-	-	1	-	-	1	1	-	1	-

Detailed Syllabus:

1. Calibration of Venturimeter, Orifice meter (discharge measuring device in pipes)
2. Calibration of Orifice and mouthpiece (discharge measuring device in Tanks).
3. Calibration of triangular notch and rectangular notch (discharge measuring device in Channels).
4. Measurement of viscosity of water, SAE – 10 Oil By Hazen- Poiseuille method and that of glycerin by Stokes method.
5. Determination of Darcy's friction factor, relative roughness for laminar and turbulent flows.
6. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades and Pelton bucket.

Reading:

1. K.L.Kumar."Engineering Fluid Mechanics" Experiments, Eurasia Publishing House, 2014
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995

CE207	SURVEYING LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Understand the field conditions to plan and collect field data
CO2	Prepare field notes from surveyed data
CO3	Interpret survey data and compute areas and volumes
CO4	Map details and elevations from field data
CO5	Set out alignments of engineering constructions in the field

Course Articulation Matrix:

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	1	2	3	2	2	2	3	3	3	1	3	1	2	1
CO2	1	1	1	1	2	1	1	1	1	1	2	1	2	1	2	1
CO3	3	2	2	2	3	1	1	2	2	2	1	2	3	1	2	1
CO4	2	2	1	1	1	1	1	1	2	2	2	2	2	2	2	1
CO5	2	3	3	2	2	1	1	2	3	2	3	2	2	1	3	2

Detailed Syllabus:

1. Measurement of a line using a chain taking offsets on both sides
2. Traversing using compass.
3. Measurement of horizontal angle using Theodolite by Repetition method.
4. Differential Levelling.
5. Profile Levelling and Cross sectioning.
6. Grid Contouring
7. Plane table traversing
8. Direct contouring using plane tabling
9. Setting out simple curve using theodolite.
10. Introduction to Total Station.
11. Total station traversing.
12. Introduction to GPS

Reading:

1. B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2015
2. Chandra A. M., Higher Surveying, New Age International Publishers, 2007
3. Chandra A. M., Plane Surveying, New Age International Publ., 2007
4. James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012
5. Charles D Ghilani, Paul R Wolf., Elementary Surveying, Prentice Hall, 2012

CE251	MECHANICS OF MATERIALS	PCC	3-0-0	3 Credits

Pre-requisites: CE201- Strength of Materials

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

CO1	Determine slope and deflection of beams
CO2	Analyze columns and struts
CO3	Understand the concept of failure theories
CO4	Analyze and design springs and thick cylinders

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	3	-	1	-	1	1	-	-	-	-	3	1	1
CO2	2	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1
CO3	1	3	1	1	-	1	-	1	1	-	1	-	-	3	1	1
CO4	2	3	2	3	-	1	-	1	1	-	1	-	-	3	1	1

Detailed Syllabus:

1. Strain Energy in Flexure and Castigliano's Theorem: Strain Energy of Beams in bending - Deflection of beams from Strain Energy. Castigliano's Theorem I - application to statically determinate beams for determining slopes and deflections.
2. Thick cylinders - Lame's theory - Shrink fit allowance - compound cylinders
3. Columns and Struts: Direct and Bending stresses - Kernel of a section - Euler's critical load for columns with ordinary end conditions - Slenderness ratio and effective length of a column - Rankine's Formula - IS Code formula - Critical load of eccentrically loaded columns.
4. Principal Stresses and Strains at a Point: Analysis of Biaxial state of stress at a point - Principal Planes - Principal stresses and strains - Mohr's Circle and its application to different cases - combined bending and torsion with or without end thrust - Equivalent Bending Moment and Equivalent Twisting Moment.
5. Failure Theories: (1) Maximum Principal Stress Theory (2) Maximum Principal Strain Theory (3) Maximum Shear Stress Theory (4) Strain Energy Theory (5) Distortion energy theory - Applications.
6. Springs: Types and classification of springs – Analysis of Close and Open coiled helical springs subjected to axial load and axial twist – Compound springs - Leaf springs.
7. Shear Centre: Concept of Shear Centre – Shear Centre of various cross sections – Shear flow – Shear lag.
8. Unsymmetrical bending of straight beams

Reading:

1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.
2. T.D.Gunneswra Rao and Mudimby Andal, Strength of Materials - Fundamentals and Applications, Cambridge University Press, 1st Edition, 2018.
3. S.B.Junarkar, Mechanics of Structures, Charotar Publishers, Anand, 1998.
4. Strength of Materials - Pytel & Singer, Harper & Row Publishers, 2018.

CE252	FLUID MECHANICS-II	PCC	3-0-0	3 Credits

Pre-requisites: CE202-Fluid Mechanics-I

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

CO1	Compute drag and lift coefficients using the theory of boundary layer flows
CO2	Design channels
CO3	Compute the flow profiles in channel transitions
CO4	Formulate and solve the problem of propagation of flood wave and surges in channels
CO5	Design experimental procedure for physical model studies
CO6	Design the working proportions of hydraulic machines

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	2	-	-	-	-	-	-	-	1	-	-	3	-
CO2	3	3	3	1	-	-	-	-	-	-	-	1	-	-	3	-
CO3	3	3	2	2	2	-	-	-	-	-	-	1	-	-	3	-
CO4	3	3	2	2	3	-	-	-	-	-	-	1	-	-	3	2
CO5	3	2	3	3		-	-	-	-	-	-	1	-	-	3	-
CO6	3	3	3	3	2	-	-	-	-	-	-	1	-	-	3	-

Detailed Syllabus:

1. Boundary Layer Theory: Concepts of boundary layer flows, Laminar and turbulent boundary layers, Integral momentum equation for boundary layer flows, Boundary layer separation and control, Drag and lift.
2. Uniform Flow in Open Channels Specific energy, Critical flow, Channel transitions, Uniform flow formulae, Best hydraulic sections.
3. Steady Gradually Varied Flow, Non uniform flow in open channels, Gradually varied flow equation, Type of GVF profiles, Computation of GVF profiles.
4. Steady Rapidly Varied Flow Hydraulic jump in a horizontal rectangular channel, Specific force, Computation of energy loss.
5. Unsteady Flow: Celerity of a gravity wave, Monoclonal rising wave, Positive and negative surges, St. Venant's equations, Method of characteristics, Hydraulic routing.
6. Hydraulic Similitude: Review of dimensional analysis, Similarity laws, Model studies.
7. Hydraulic Machinery: Classification of hydraulic machines , Euler's equation of turbo machines, One dimensional flow analysis and velocity triangles, Design of Pelton turbine, Design of Francis turbine, Design of centrifugal pump, Design of a Kaplan turbine/ axial flow pump, Selection of hydraulic machines.
8. Compressible Flows: Celerity of an elasticity wave, Area velocity relationships, Flow through nozzles, Constant area flow, Normal shocks, Water Hammer.

Reading:

1. Chow V.T. Open Channel Hydraulics, Blackburn Press , 2009
2. Franck M White, Fluid Mechanics, Tata Mc Graw Hill Publications 2011.
3. Robert W. Fox Ogukuo H. Orutcgardm Alan T. Mc Donald, Introduction to Fluid Mechanics, Student Edition 7th Wiley India Edition, 2011.
4. Subramnaya, K., Flow In Open Channel, Tata McGraw Hill Publications, New Delhi, 2008.

CE253	DESIGN OF STEEL STRUCTURES	PCC	3-0-0	3 Credits

Pre-requisites: CE201- Strength of Materials

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

CO1	Design bolt and weld connections
CO2	Design tension and compression members
CO3	Design beams and beam columns
CO4	Design built up members and column base

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-

Detailed Syllabus:

1. Introduction: General- Types of Steel – Mechanical behaviour of steel – Measures of Yielding – Measures of Ductility – Types of Structures – Structural Steel Sections.
2. Methods of Structural design: Introduction-Design Philosophies-Working Stress method-Ultimate Strength method-Load and Resistant factor- Limit State Method-Partial safety factor-Load-Load combinations-Classification of Cross sections- General aspects in the design.
3. Design of Steel fasteners: Types of fasteners – Riveted connections- Bolted connections-Assumptions- Failure of bolted joints – Strength of bolted joints – Design examples – Design of Welded connections – Butt weld- fillet weld – Design examples.
4. Design of Tension Members: General – Modes of Failure of Tension member- Analysis of Tension members- Example - Design steps – Design examples – Lug angles – Design.
5. Design of Compression Members: General – Strength of Compression members- Design Compressive strength- Example on analysis of Compression members – Design of Angle struts – Design Examples- Built up Columns- Design of Lacing – Design of Battens- Design Examples- Design of Roof members.

6. Design of Beams: General- Lateral Stability of Beams- Bending Strength of Beams – Plastic Section Modulus - Design Examples.
7. Design of Beam Columns: Behaviour of members under combined loading – Modes of Failures – Design Examples.
8. Design of Column Splices and Column Base: Design of Column Splice-Design Examples- Design of Column Base- Slab Base- Gusseted Base- Design Examples.
9. Design of Eccentric Connections: Design of Brackets- Type-1 and Type 2 – Moment Resistant connections - Design Examples.
10. Design of Plate Girder: General- Components of Plate Girder- Optimum depth – Bending Strength – Shear Strength – Shear Buckling- Simple Post critical method- Tension Field method- Stiffeners-Bearing- Transverse stiffeners - Design Examples.

Reading:

1. Limit State Design of Steel Structures – S.K.Duggal, TMH Education Pvt Ltd, 2nd Edition, 2014
2. IS-800-2007, BIS Publication
3. Steel Structures : Design and Practice- N.Subramanian, Oxford Pub, 2011
4. Design of Steel structures – S.S. Bhavikatti, IK International Pub Pvt Ltd, 4th Edition

CE254	BUILDING PLANNING AND CONSTRUCTION	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Identify the factors to be considered in planning and construction of buildings
CO2	Plan a building based on the factors and principles of planning
CO3	Understand the different component parts of building and their construction practices and techniques
CO4	Understand the functional requirements to be considered for design and construction of building

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	2	-	-	-	2	1	-	-	3	-	-	3	-	2	-
CO2	2	-	-	-	-	2	2	-	-	3	-	-	-	-	3	-
CO3	3	-	2	-	-	-	2	-	-	-	-	-	-	2	2	-
CO4	3	-	2	-	-	-	2	-	-	-	-	-	-	2	2	-

Detailed Syllabus:

1. Functional Planning of buildings: Sustainability and concept of Green building, General aspects to consider for planning, bye-laws and regulations, Selection of site for building

construction, Principles of planning, Orientation of building and its relation to outside environment

2. Components of buildings, Foundation and its functional requirements, Characteristics of soil, types of foundations, construction of foundation
3. Masonry: Definitions of terms used in masonry, Materials used, Stone masonry, Brick masonry, Different bonds used for brick masonry, Permissible stress of brick masonry work
4. Floors and Roofs: Components of a floor, materials used for floor construction, Different types of flooring, Ground floor and upper floors, Types of roofs, Basic roofing elements and Roof coverings.
5. Staircases: Functional requirements of a good stair, type of steps, type of stairs, planning a stair case.
6. Functional requirements to be considered for design and construction of buildings: Damp proofing, Fire protection and Thermal insulation: Causes and effect of dampness on buildings, Materials and methods used for damp proofing, Fire hazards, Grading of buildings according to fire resistance, Fire resisting properties of common building materials, Fire resistant construction, General methods of thermal insulation and thermal insulating materials.

Reading:

1. Varghese P. C. Building construction, PHI Learning Pvt. Ltd., 2008.
2. Punmia B. C., Jain A. J. and Jain A. J. Building construction, Laxmi Publications, 2005.
3. Arora S. P., and Bindra S. P. The text book of building construction, Dhanpat Rai Publications, 2010.
4. National Building Code of India, 2016.

CE255	CONCRETE TECHNOLOGY	PCC	3-0-2	4 Credits

Pre-requisites: None

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

CO1	Identify Quality Control tests on concrete making materials
CO2	Understand the behavior of fresh and hardened concrete
CO3	Design concrete mixes as per IS and ACI codes
CO4	Understand the durability requirements of concrete
CO5	Understand the need for special concretes

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	-	-	-	2	-	2	-	-	2	-	-	3	2	-
CO2	-	3	2	-	-	2	-	2	-	-	2	-	-	2	3	-
CO3	-	-	3	2	-	2	-	2	-	-	2	-		2	3	-
CO4	-	3	2	3	-	2	-	2	-	-	1	-		2	3	2
CO5	-	2	2	2	-	2	-	2	-	-	1	-	-	3	2	2

Detailed Syllabus:

1. Concrete Making Materials: Cement, Fine Aggregate, Coarse aggregate, Water, Chemical & Mineral admixtures.
2. Hydration of Cement: Bogue's compounds, Hydration, Gel formation, Types of cement, pore & capillary water.
3. Quality tests on cement: Different test on cement as per Indian standards
4. Aggregates: Tests on aggregates as per Indian standards, Bulking of sand, Sieve analysis – Grading.
5. Fresh concrete: Properties of fresh concrete- Workability – different tests of workability- Factors influencing workability compaction, finishing, curing.
6. Hardened concrete: Tests on hardened concrete as per IS codes – Relationship between different strengths – factors influencing strength, NDT techniques.
7. Durability: Factors influencing durability – Chemical effects on concrete- Carbonation, Sulphate attack, Chloride attack.
8. Concrete Mix design: Different methods of mix design – factors affecting mix design – exercises.
9. Special concrete: Heavy density concrete, underwater concrete, self-compacting concrete, light weight concrete etc.

Reading:

1. Properties of Concrete – AM Nevelli – 5th Ed, Prentice Hall Publishers, 2012.
2. Concrete Technology – M. S. Shetty – S Chand Co., Publishers – 2006.
3. Concrete Technology – M. L. Gambhir – Tata Mc Graw Hill Publishers – 2012.

CONCRETE LABORATORY

1. Determination of Fineness and Specific Gravity of cement.
2. Determination of consistency of standard Cement Paste.
3. Determination of initial and Final Setting times of Cement.
4. Determination of Compressive Strength of Cement.
5. Determination of Fineness modulus of Coarse and Fine Aggregates.
6. Determination of percentage of voids, Bulk density, Specific Gravity of coarse and Fine Aggregates.
7. Workability Tests: Slump Cone Test, Compaction factor test, Vee-Bee consistometer Test.
8. Preparing and curing concrete specimens for tests & Determination of compressive strength of concrete cubes.

9. Study of stress - strain characteristics of concrete and tests for tensile strength of concrete.
10. Experiments to demonstrate the use of non-destructive test equipment.
11. Mix Design: IS Code method.

Reading:

1. Properties of Concrete, AM Nevelli – 5th Ed, Prentice Hall Publishers, 2012.
2. Concrete Technology, M. S. Shetty – S Chand Co., Publishers, 2006.
3. Concrete Technology, M. L. Gambhir – Tata Mc Graw Hill Publishers, 2012.

CE256	ENGINEERING GEOLOGY	PCC	3-0-2	4 Credits

Pre-requisites: None

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

CO1	Understand weathering process and mass movement
CO2	Identify geological formations and structures for rock mass quality assessment
CO3	Identify subsurface information and groundwater potential sites through geophysical investigations
CO4	Apply geological principles for mitigation of natural hazards and select sites for dams and tunnels

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	-	-	-	-	-	-	-	2	2	2	2	2	2	2	2
CO2	1	2	-	2	-	-	2	-	2	2	2	2	3	3	2	2
CO3	2	2	3	3	3	2	2	2	2	2	3	3	2	2	3	3
CO4	2	2	2	2	3	2	2	1	3	2	3	2	2	2	3	3

Detailed Syllabus:

1. General Geology: Branches and scope of geology, Importance of geology in Civil engineering. Earth-surface features and internal structure, weathering of rocks.
2. Minerology: Definition of a crystal and mineral, physical properties in mineral identification, rock forming minerals and their identification – quartz and its varieties, feldspar, horneblende, olivine, mica, garnet, kyanite, calcite, talc, bauxite, corundum, gypsum, fluorite, apatite, beryl, barite, asbestos, magnetite, hematite.
3. Petrology: Formation and classification of rocks – Igneous, Sedimentary and metamorphic rocks, their texture and structures, properties of granite, pegmatite, dolerite, gabbro, charnockite, basalt, sandstone, conglomerate, breccia, limestone, shale, laterite, schist, gneiss, quartzite, marble, khondalite and slate. Drilling Techniques, Core Recovery, RQD, Engineering Properties of Rocks
4. Structural Geology: Geological Map, outcrop, attitude of beds, types and classifications of folds, faults, joints, unconformities.

5. Engineering Properties Of Rocks: Drilling, Core recovery, RQD%, Sample preparation, tests on rock samples - compression, tensile, shear and slake durability tests.
6. Ground Water: Subsurface distribution of ground water, water table, aquifers, occurrence of ground water in different geological formations, springs, ground water exploration..
7. Earthquakes And Landslides: Causes and effects of earthquakes and landslides, Remedial measures to prevent damage for engineering structures.
8. Subsurface Investigations: Soil Profile, Geophysical methods – Electrical Resistivity and Seismic refraction methods.
9. Dams: Types of dams, Requirements of dam sites, preliminary and detailed geological investigations for a dam site. Case histories of dam failures and their causes. Geology of the major dam sites of India. Factors affecting the seepage and leakage of reservoir and the remedial measures.
10. Tunnels: Purpose of tunneling, geological considerations for tunneling, geothermal step, over break, stand up time, and logging of tunnels.

Reading:

1. Text Book of Engineering Geology by N.Chenna Kesavulu, Mac Millan Ltd., New Delhi. 2009
2. Engineering and General Geology – Parbin singh, Katson Publishers. 2009
3. Principles of Engineering Geology – K.V.G.K. Gokhale, BS Publications, Hyderabad, 2005
4. Engineering Geology – F.G. Bell, Elsevier Publications, 2007.
5. Engineering Geology, D Venkat Reddy, Viskas Publishing House Pvt. Ltd., 2011

ENGINEERING GEOLOGY LABORATORY

1. Introduction to Crystallography – Identification of Crystals.
2. Introduction of minerals and the study of Physical properties, Identification of Quartz and feldspars.
3. Identification of pyroxenes and Amphiboles and other silicates.
4. Identification of important economic minerals.
5. Identification of important ore deposits.
6. Identification of Igneous rocks
7. Identification of Sedimentary rocks
8. Identification of metamorphic rocks
9. Structural geology- strike and dip, three and 3-point problems point problems.
10. Structural geology – Completion of out crops maps, order of superposition.
11. Subsurface analysis – Resistivity sounding.
12. Subsurface analysis – Seismic survey.

Reading:

1. Text Book of Engineering Geology by N.Chenna Kesavulu, Mac Millan Ltd., New Delhi. 2009

CE257	HYDRAULIC ENGINEERING LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: CE202- Fluid Mechanics-I, and CE252 - Fluid Mechanics-II

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

CO1	Compute drag coefficients
CO2	Test the performance of pumps and turbine and select appropriate Hydraulic Machines
CO3	Determine Manning's and Chezy's coefficients for smooth and rough channels
CO4	Determine energy loss in hydraulic jump
CO5	Develop procedure for standardization of experiments

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	1	3	-	1	-	-	1	-	-	1	2	-	2	-
CO2	1	1	1	3	-	1	-	-	1	-	-	1	2	-	3	-
CO3	1	2	1	3	-	1	-	-	1	-	-	1	2	-	3	-
CO4	1	2	2	3	-	1	-	-	1	-	-	1	1	-	1	-
CO5	1	2	2	3	-	1	-	-	1	-	-	1	1	-	1	-

Detailed Syllabus:

1. Determination of Manning's and Chezy's coefficients for smooth and rough channels by gradually varied flow method.
2. Determination of energy loss in hydraulic jump.
3. Calibration of standing wave flume.
4. Determination Velocity distributions in open channels.
5. Computation of pressure drag coefficient for flow past a cylinder in a subsonic wind tunnel.
6. Performance Characteristics of single stage centrifugal pump, multi stage centrifugal pump, Submersible pumps, and varying speed centrifugal pump.
7. Performance Characteristics of Pelton turbine, Francis turbine, and Kaplan turbine

Reading:

1. K.L.Kumar."Enginering Fluid Mechanics" Experiments, Eurasia Publishing House, 1997
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995

CE258	BUILDING DRAWING	PCC	0-1-2	2 Credits

Pre-requisites: ME102 - Engineering Graphics

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

CO1	Create, analyze and produce 2D drawings in AUTO CAD environment
CO2	To study and understand civil engineering drawings
CO3	Draw the plan, section and elevation of a building
CO4	Detailing building plans in CAD environment

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	3	-
CO2	-	2	-	-	3	-	-	-	-	-	2	-	-	-	-	-
CO3	-	-	3	2	3	2	-	-	3	2	2	3	1	-	3	2
CO4	-	-	2	2	3	2	2	2	2	-	2	3	-	-	2	2

Detailed Syllabus:

1. Getting started with AutoCAD.
2. Understanding the basic commands.
3. Working with commands in executing simple drawings
4. Understanding and Drawing a civil engineering structures like buildings, bridges, retaining wall, dams, pipelines, water tanks etc., with design notations.
5. Drawing various plans and elevations, isometric view & perspective view of civil engineering structures.
6. Executing a spiral and other type of stair case in 3D.
7. Drawing & detailing of steel & RC structures

Reading:

1. AutoCAD Manual

CE301	THEORY OF STRUCTURES - I	PCC	3-0-0	3 Credits

Pre-requisites: CE251 - Mechanics of Materials

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

CO1	Formulate Equilibrium and compatibility equations for structural members
CO2	Analyze one dimensional indeterminate problems using classical methods
CO3	Analyze indeterminate structures using energy methods
CO4	Analyze structures for gravity loads and moving loads

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO2	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO3	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO4	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-

Detailed Syllabus:

1. Indeterminate beams - Propped cantilever, Fixed and Continuous beams - Analysis for shear force and bending moment - Clapeyron's theorem of three moments - Slope and deflection - effect of sinking of supports.
2. Column Analogy Method: Application to fixed beams - Application to non-prismatic members - stiffness coefficients.
3. Slope - Deflection Method: Analysis and application to continuous beams - portal frames (single bay - Single storey).
4. Moment-Distribution Method: Analysis of continuous beams and portal frames (single storey - single bay).
5. Moving Loads: Maximum bending moment and shear force diagrams for simply supported spans traversed by single point load - two concentrated loads - Uniformly distributed load, shorter and longer than the span - enveloping parabola and equivalent uniformly distributed load, determination of maximum bending moment and shear force for a system of concentrated loads on simply supported girders - focal length of a girder - counter bracing.
6. Influence Lines: Influence lines for reaction bending moment and shear force diagrams for simply supported beams - stresses in members of statically determinate pin jointed plane frames due to moving loads.

Reading:

1. L.S. Negi, Theory and Problems in Structural Analysis, Tata McGraw Hill Pub, 1997.
2. Junarkar. S. B and Shah H.J- Mechanics of Structures Vol 1 & Vol.2 – 27th Edition, Charotar Publishers, 2008.
3. Wang C.K. - Intermediate Structural Analysis – Tata McGraw Hill Publishers, 2010.

CE302	DESIGN OF CONCRETE STRUCTURES	PCC	3-0-0	3 Credits

Pre-requisites: CE255 - Concrete Technology; CE201 - Strength of Materials

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

CO1	Design the Reinforced Concrete beams using limit state and working stress methods
CO2	Design Reinforced Concrete slabs
CO3	Design the Reinforced Concrete Columns and footings
CO4	Design structures for serviceability
CO5	Design stair cases, canopy, retaining wall and water tanks

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-

Detailed Syllabus:

1. Introduction- Review of Concrete making materials- Structural concrete- Grades- properties of Concrete- Modulus of elasticity-flexural strength-Characteristic and Design values-Partial safety factor.
2. Methods of design- Aims of design- RCC- Limit State method- Assumptions- Stress-Strain behavior of Steel and Concrete- Stress block parameters- Working stress method- comparison of design process.
3. Analysis and Design of Singly Reinforced Beams- Analysis of Singly Reinforced RC Section- Neutral axis-Balanced-Under Reinforced-Over Reinforced Sections- Moment of Resistance- Design parameters- Design examples.
4. Analysis and Design of Doubly Reinforced Beams- Necessity of Doubly Reinforced sections- Analysis of Doubly Reinforced RC Section-Moment of Resistance- Design parameters- Design.
5. Shear and Bond design of RCC- Shear forces in RC-Shear Resistance of RC- Truss analogy- design of Vertical stirrups-Bent-up bars- Limitation- Bond failure in RC- Check for bond resistance-Development length-Design for shear and bond.
6. Analysis and Design of Flanged Beams- Analysis of flanged RC section- Singly and Doubly reinforced-Effective flange width- Moment of Resistance- design examples.
7. Design of RCC Slabs- Design of One and Two way slabs- Effect of edge conditions- Moment of resistance-Torsion reinforcement at corners- Design examples.
8. Design of Continuous Slab and Beams- Effect of continuity- analysis of continuous beam/slab- Moment and shear coefficients for continuous beam/slab- Critical sections.
9. Design of RC Columns- Design principles of RC columns- Assumptions- Rectangular and Circular columns- Helical reinforcement- Minimum eccentricity-Use of Interaction diagrams for Axial load and Moment.
10. Design of RC Footings- RC footings-Minimum depth of footing- Safe bearing capacity- Design for Bending-Shear in One way and Shear in Two way- Transfer of load at base of column.
11. Design for Serviceability- Concept of Serviceability- Deflection- Span to depth ratio- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation.
12. Design of Miscellaneous RC Structures- Design of Stair case – Design of Canopy Slab and Beam – Design of cantilever Retaining walls- Design of RC Circular Water tank- Design of single story RC Building.

Reading:

1. Limit State Design of Reinforced Concrete Structures – B.C.Punmia, Ashok.K.Jain and Arun.K.Jain, Laxmi Pub. Pvt Ltd, Edition, 2016
2. IS-456-2000, BIS Publication
3. Design of Reinforced Concrete Structures - N.Krishnaraju, CBS Pub, 2016
4. Design of Reinforced Concrete structures – N.Subramanian, Oxford Pub Pvt Ltd, 2013
5. Reinforced Concrete Design - Unnikrishnan & Pillai, McGraw Hill Pub, 2009

CE303	ENGINEERING HYDROLOGY	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Analyze hydro-meteorological data
CO2	Estimate abstractions from precipitation
CO3	Compute yield from surface and subsurface basin
CO4	Develop rainfall-runoff models
CO5	Formulate and solve hydrologic flood routing models

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	3	2	-	-	-	-	-	-	1	3	-	1	2
CO2	2	3	1	2	2	-	-	-	-	-	-	1	3	-	1	-
CO3	3	3	3	2	2	-	-	-	-	-	-	1	2	-	3	-
CO4	3	3	2	2	3	-	-	-	-	-	-	1	2	-	2	3
CO5	3	3	2	2	3	-	-	-	-	-	-	1	1	-	2	3

Detailed Syllabus:

1. Introduction: Description of Hydrologic Cycle, Overview of application of hydrology in engineering, Forms and types of precipitation, basic concepts of weather systems, characteristics of precipitation in India.
2. Precipitation: Measurement of precipitation, types of rain gauges, rain gauge network, collection and presentation of rainfall data, Test for consistency and continuity of data, analysis of rainfall data, average precipitation over an area, intensity-duration-frequency analysis and depth-area-duration analysis.
3. Abstractions from Precipitation: Evaporation and Evaporation Process, measurement, estimation and control of evaporation, Evapotranspiration, measurement and estimation of evapotranspiration, interception and depression storage, Infiltration process, measurement of infiltration, infiltration models and infiltration indices and effective rainfall.

4. Stream Flow Measurement: Methods of measurement of stream flow, stage-discharge relationship, Runoff characteristics, catchment characteristics effecting the runoff, yield from a catchment, flow duration curve and flow mass curve.
5. Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models, synthetic unit hydrograph and its derivation.
6. Floods: Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Design flood, return period, flood frequency analysis, probabilistic and statistical concepts. Gumbel's and log Pearson Type III methods.
7. Flood Routing: Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting.
8. Groundwater: Occurrence of groundwater, types of aquifers, aquifer properties, Groundwater movement, Darcy's law, Conductivity and Transmissivity, yield from a well under steady state conditions, Pumping tests, unsteady flow in unconfined aquifers, well losses and specific capacity.

Reading:

1. Subrahmanya, K., 2008, Engineering Hydrology, Tata Mc Graw Hill Pub. Co., New Delhi.
2. Chow, V. T., Maidment and Mays, L. A., 2010, Applied Hydrology, Tata Mc Graw Hill Pub. Co., New York
3. Viesmann W and Lewis G Lt (2008) "Introduction to Hydrology". Prentice Hall of India
4. Ojha CSP, R. Berndstsson and P Bhunya (2008), Engineering Hydrology, Oxford University Press Co., New Delhi.

CE304	GEOTECHNICAL ENGINEERING - 1	PCC	3-1-0	4 Credits

Pre-requisites: None

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

CO1	Characterize and classify soils
CO2	Understand the effective stress principle under various field conditions
CO3	Identify the shear strength parameters for field conditions
CO4	Analyze and compute the consolidation settlements
CO5	Understand the stress distribution under applied loads
CO6	Understand the principles of compaction and its control

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	1	2	2	-	-	-	-	-	-	-	-	-	3	2	-
CO3	3	3	-	2	-	-	-	-	-	-	-	-	-	3	2	-
CO4	3	1	-	3	-	-	-	-	-	-	-	-	-	3	3	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-	-	-	3	-
CO6	3	3	-	3	-	-	-	-	-	-	-	-	-	2	3	-

Detailed Syllabus:

1. Introduction: Soil formation- Development of soil mechanics- Importance of soil engineering- Major soil deposits of India.
2. Basic Definitions and Relationships: 3-phase soil system, Volumetric relationships and weight -volume relationships.
3. Determination of Index Properties: Water content, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg limits and indices.
4. Classification of Soils: Classification of soil systems – Particle size classification, Textural classification, AASHTO classification, Unified soil classification and Indian soil classification- Field identification of soils, Relative suitability of soils for engineering works based on soil classification.
5. Soil Water: Types of soil water, Capillarity in soils, Permeability of soils, Darcy's law, Determination of permeability of soils, Permeability of stratified soils, Field permeability determination, Seepage velocity, Absolute coefficient of permeability, Factors affecting permeability- Effective stress principle- Effective stress under different field conditions- Seepage pressure-Quick sand condition.
6. Compaction of Soils: Definition and importance of compaction – Standard Proctor compaction test, Modified compaction test- Factors affecting compaction- Influence of compaction on soil properties – Field compaction and its control, Relative compaction.
7. Stress distribution in Soils: Importance of estimation of stresses in soils – Boussinesq's and Westergaard's theories for point loads, uniformly loaded circular and rectangular areas, pressure bulb, variation of vertical stress under point load along the vertical and horizontal planes – Newmark's influence chart, Contact pressure distribution in sands and clays.
8. Consolidation: Types of compressibility – Immediate settlement – Primary consolidation and secondary consolidation – Stress history of clay, Normally consolidated soil, Over consolidated soil and under consolidated soil- preconsolidation pressure and its determination- Consolidation test, Estimation of settlements -Terzaghi's 1-D consolidation theory – Coefficient of consolidation and its determination - Spring analogy.
9. Shear Strength: Definition and use of shear strength - Source of shear strength- Normal and Shear stresses on a plane – Mohr's stress circle- Mohr-Coulomb failure theory- Measurement of shear strength, Drainage conditions -Direct shear test, Triaxial shear test,

Unconfined compression test and vane shear test – Factors affecting shear strength of granular soils and cohesive soils. Hvorslev shear strength parameters.

10. Stability of Soil Slopes: Types of slopes – Types of slope failures – Slip circle method, Determination of centre of most critical slip circle – Taylor's stability charts and their use. Stabilisation of soil slopes

Reading:

1. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, Wiley Eastern Ltd., New Delhi, 2016.
2. Soil Mechanics and Foundation Engg by V.N.S. Murthy, CBS Pub. New Delhi. 2007.
3. Essentials of Soil Mechanics and Foundations – Basic Geotechnics by David F.McCarthy, 2015, Pearson Pub., New Delhi.
4. Soil Mechanics and Foundation Engineering by B.N.D. Narsinga Rao, 2015, Wiley India Pvt. Ltd. New Delhi.
5. Geotechnical Engineering by Debashis Moitra, 2016, University Press (India) Pvt. Ltd. Hyderabad
6. Criag's Soil Mechanics - CRC Press - 2012

CE305	TRANSPORTATION ENGINEERING-1	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Plan highway networks
CO2	Design highway geometrics
CO3	Understand the principles of traffic engineering
CO4	Analyze and design flexible pavements
CO5	Analyze and design rigid pavements

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	3	2	2	1	1	-	-	-	-	1	-	-	-	3
CO2	3	3	3	2	3	1	1	-	-	-	-	1	3	-	3	2
CO3	3	2	-	-	2	-	1	-	-	-	-	1	1	-	3	2
CO4	3	3	3	3	2	2	2	-	-	-	-	1	3	2	3	1
CO5	3	3	3	3	2	2	2	-	-	-	-	1	3	2	3	1

Detailed Syllabus:

1. Highway Network Planning: Different modes of transportation, role of highway transportation, classification, network patterns, planning surveys, preparation of plans, final

report, master plan, evaluation by saturation system, 20 year road development plans, salient features, determination of road lengths, introduction to highway economics.

2. Highway Alignment And Geometric Design: Principles of highway alignment, requirements, controlling factors, engineering surveys, importance of geometric design, design controls and criteria, cross section elements, pavement surface characteristics, camber, carriageway, kerbs, road margins, formation, right of way, typical cross sections, sight distance, stopping sight distance, overtaking sight distance, sight distance at intersections, design of horizontal alignment, super elevation, transition curves, design of vertical alignment, gradients, vertical curves.
3. Traffic Engineering Principles: Traffic characteristics; components of traffic stream: flow-speed-Density, measurement and analysis, q-k-v relationships, design hourly volume, concept of EPCU, capacity and level of service, parking studies and road safety.
4. Pavement Materials and Mix Design: Types of pavement structures, functions of pavement component layers, materials used in pavements, basic soil properties relevant to pavement applications, properties of aggregate, blending of aggregates, tests on bitumen, grading of bitumen, bituminous mix design using Marshall method.
5. Design of Pavements: Stresses in flexible pavements: layered system concepts, stress solution for one, two and three layered systems, fundamental design concepts; variables considered in pavement design: axle types, standard and legal axle loads, ESWL, EWLF, vehicle damage factor, ADT, AADT, growth factor, lane distribution factor, directional distribution factor, tyre pressure, contact pressure, design life; design of flexible pavement using IRC method; stresses in rigid pavements: Westergaard's theory and assumptions, stresses due to curling, stresses and deflections due to loading, frictional stresses, design of joints; design of rigid pavement using IRC method.

Reading:

1. Kadiyali L.R. Traffic Engineering and Transport Planning, Ninth Edition, Khanna Publishers, New Delhi, India, 2017.
2. Khanna, S.K., C.E.G. Justo and Veeraragavan. Highway Engineering, Tenth Edition, Nem Chand and Bros., Roorkee, India, 2017
3. Chakroborty, P. and A. Das. Principles of Transportation Engineering, Second Edition, Prentice Hall of India Pvt. Ltd, New Delhi, India, 2017.
4. Huang, Y.H. Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA, 2008.
5. Jotin Khisty C. and B. Kent Lall. Transportation Engineering – An Introduction, Third Edition, Prentice Hall of India Pvt. Ltd, New Delhi, India, 2002.
6. Kandhal, P.S. Bituminous Road Construction in India, PHI Learning Pvt. Ltd., New Delhi, India, 2016.
7. Papacostas C.S. and P.D. Prevedouros. Transportation Engineering and Planning, Third Edition. Prentice Hall of India Pvt. Ltd, New Delhi, India, 2002.
8. Yoder, E.J. and M.W. Witczak. Principles of Pavement Design, Second Edition, John Wiley and Sons, New York, USA, 2012.

CE306	ENVIRONMENTAL ENGINEERING - I	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Analyze characteristics of water, air and noise and interpret their importance
CO2	Assess water demand and design components of water distribution systems
CO3	Plan and design water treatment units
CO4	Assess sources and effects of air and noise pollution and identify appropriate control devices

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	1	1	3	1	1	-	-	-	1	-	-	-	-
CO2	3	3	3	1	2	3	1	1	-	-	-	1	-	-	2	-
CO3	3	3	3	1	2	3	1	1	-	-	-	1	-	-	2	-
CO4	2	1	1	1	1	3	2	1	-	-	-	1	-	-	-	-

Detailed Syllabus:

1. Sources, Quality and Quantity Perspectives of Water: Surface sources, subsurface sources, physical, chemical and biological characteristics, Estimation of water demand, water consumption rate, fluctuations in rate of demand, design period, population forecasting methods.
2. Collection and Conveyance of Water: Intakes, types of Intakes, factors governing location of intakes, pumps, types of conduits, types of pipes, pipe appurtenances
3. Water Treatment: Working principles and design of water treatment units, screening, plain sedimentation, sedimentation aided with coagulation, filtration, disinfection, water softening, miscellaneous treatments.
4. Distribution System: Requirements of a good distribution system, methods of distribution, systems of supply of water, Distribution reservoirs, layout of distribution system, design of distribution system, analysis of pipe networks, appurtenances in distribution system, detection and prevention of wastage of water in distribution system.
5. Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.
6. Noise Pollution: Types of noise, Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Reading:

3. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous (1985), Environmental Engineering, McGraw Hill Inc., New York.
4. P.N. Modi (2006), Water supply Engineering – Environmental Engineering (Vol.I) – Standard Book House.
5. S.K. Garg (1999), Water supply Engineering – Environmental Engineering (Vol.I) – Khanna Publishers.

6. S.K. Garg (1999), Sewage Disposal and Air Pollution Engineering – Environmental Engineering (Vol.II) – Khanna Publishers.
7. Masters, G.M. (1994), Introduction to Environmental Engineering and Science, Prentice Hall of India, New Delhi.
8. Nicholas P. Cheremisinoff (2002), Handbook of Water and Wastewater Treatment Technologies, Butterworth- Heineman.
9. CPHEEO Manual on water supply and Treatment, 1999

CE307	TRANSPORTATION ENGINEERING LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Conduct traffic studies for estimating traffic flow characteristics
CO2	Characterize the pavement materials
CO3	Perform quality control tests on flexible pavements and flexible pavement materials
CO4	Estimate earth work from longitudinal and cross-section details
CO5	Design at-grade intersections

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	3	2	-	-	2	3	2	1	1	-	-	3	2
CO2	2	2	-	2	-	-	-	2	2	2	-	1	3	3	1	-
CO3	3	2	2	3	1	-	-	2	2	2	-	1	1	3	1	1
CO4	2	2	3	2	2	-	1	-	-	-	-	1	3	-	3	1
CO5	3	3	3	1	2	-	-	-	-	-	-	1	-	-	3	1

Detailed Syllabus:

1. Tests on Aggregate: aggregate gradation, combined flakiness and elongation tests, specific gravity test, water absorption test, aggregate impact test, Los Angeles abrasion test, demonstration of soundness test.
2. Tests on Bitumen: penetration test, flash and fire point tests, ductility test, softening point test, specific gravity test, demonstration of absolute and kinematic viscosity tests, demonstration of rolling thin film oven test.
3. Tests on Bituminous Mixtures: bituminous mix design using Marshall stability test, stripping value of aggregates, demonstration of retained tensile strength test, demonstration of bitumen extraction.
4. Tests on Soil: California bearing ratio test.
5. Field tests: pavement unevenness using MERLIN, and pavement layer density using sand replacement method.

6. Traffic Studies: traffic volume studies for mid block section and intersection, spot speed studies, headway distribution studies, parking usage survey; drawing of highway longitudinal section, cross sections in embankment and cutting, and earthwork calculations; design and drawing of plain and rotary intersection

Reading:

1. Khanna, S.K., Justo, C.E.G. and A. Veeraragavan Highway Materials and Pavement Testing, 5th Edition, Nem Chand and Bros, Roorkee, India, 2009.
2. Kadiyali, L.R. Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 1997.
3. IRC codes; IS Codes; ASTM Codes

CE308	GEOTECHNICAL ENGINEERING LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Determine index properties of soils
CO2	Classify soils
CO3	Determine engineering properties of soils

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	-	-	2	-	-	-	-	2	-	-	-	1	3	-	-
CO2	-	-	-	-	-	-	-	1	-	-	-	-	1	3	-	-
CO3	1	-	-	2	-	-	-	-	2	-	-	-	-	3	1	-

Detailed Syllabus:

1. Specific Gravity of soil particles.
2. Sieve Analysis.
3. Liquid Limit, Plastic Limit & Shrinkage Limit.
4. Proctor's Standard Compaction Test.
5. Determination of Field Density.
6. Constant Head Permeameter Test.
7. Variable Head Permeameter Test.
8. Unconfined Compression Test.
9. Triaxial Compression Test (U.U Test).
10. Consolidation Test.

Reading:

1. Soil Mechanics Laboratory Manual

CE351	THEORY OF STRUCTURES - II	PCC	3-0-0	3 Credits

Pre-requisites: CE301 - Theory of Structure - I

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

CO1	Formulate Equilibrium and compatibility equations for structural members
CO2	Analyze one dimensional and two dimensional structures using matrix methods of structural analysis
CO3	Analyze structures up to three degrees of indeterminacy
CO4	Analyze cables and suspension bridges
CO5	Determine dynamic parameters for single degree of freedom vibration problems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO2	1	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO3	2	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO4	2	3	2	2	-	1	-	1	-	-	1	-	-	1	3	3
CO5	3	3	-	2	-	1	-	1	-	-	1	-	-	1	3	3

Detailed Syllabus:

1. **Introduction to Matrix Methods:** flexibility and stiffness influence coefficients, Order of Indeterminacy – Flexibility and stiffness Matrix- inversion- MAT Lab applications
2. **Flexibility Method:**Basic principles - choice of redundants - released structure - application of fixed beams, continuous beams and frames (jointed) upto two degree static indeterminacy, portal frames higher degree static indeterminacy- verification by computer aided analysis
3. **Stiffness Method:**Concept of stiffness method - restrained structure - applications to continuous beams and portal frames up to two degree of kinematic indeterminacy, portal frames higher degree static indeterminacy- verification by computer aided analysis
4. **Three Hinged Arches:** Action of an arch - eddy's theorem - Three hinged, parabolic and segmental arches - determination of horizontal thrust, bending moment, normal thrust and radial shear, Influence lines for three hinged arches.
5. **Two Hinged Arches:** Determinations of horizontal thrust, bending moment, normal thrust and radial shear for parabolic and segmental shapes, Influence lines for two hinged arches - effect of rib shortening - temperature effects - tied arches.
6. **Suspension Bridges:** Force in loaded cable and hanging cables - length of cables for different support conditions - simple suspension bridges with three hinged and two hinged stiffening girders - bending moments and shear force diagrams, influence lines - temperature effects on cables and stiffening girders.
7. **Kani's method** - Application to continuous beams and portal frames (Single bay two storey)

8. **Approximate methods of analysis** - Portal method - Cantilever method - Substitute frame method

Reading:

1. R L Jindal, "Indeterminate Structures", S.Chand & Co. , N.Delhi,
2. Wang C.K. - Intermediate Structural Analysis.
3. Reddy C.S. - Basic structural Analysis - Tata Mc Graw - Hill Publishing Company Ltd.
4. Rajasekaran & Sankara Subramanian, Computational Structural Mechanics, PHI, 2003.

CE352	IRRIGATION ENGINEERING	PCC	3-1-0	4 Credits

Pre-requisites: None

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

CO1	Plan an Irrigation System
CO2	Design irrigation canals and canal network
CO3	Plan and design diversion head works
CO4	Design irrigation canal structures
CO5	Analyze gravity and earth dams
CO6	Design spillways and energy dissipation works

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	2	3	1	2	-	-	-	-	1	2	-	3	2
CO2	3	3	3	1	2	1	1	-	-	-	-	1	2	-	3	-
CO3	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	-
CO4	3	3	3	2	3	1	1	-	-	-	-	1	1	-	3	2
CO5	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3
CO6	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3

Detailed Syllabus:

1. Irrigation Systems: Types of irrigation systems, Soil moisture, Irrigation water requirements, Irrigation efficiencies, Methods of application of irrigation water, Water logging – Causes and remedial measures
2. Canal Systems: Types of canals, Principles of design of stable irrigation canals, Silt theories, Tractive force theory, Design of lined canal, Design of longitudinal section
3. Surface and subsurface flow analysis in hydraulic structures: Hydraulic structures on permeable foundation, Seepage theories, Principles of design of hydraulic structures on permeable foundation, Principles of energy dissipation

4. Design of diversion head works: Types of hydraulic structures, Layout of a diversion head work, Design of vertical drop weir, Design of sloping glacis weir, Silt control in head works

5. Design of Canal Structures: Canal regulators, Types of canal falls, Design of Sarda type fall, Design of straight glacis fall, Types of cross drainage works, Design of canal fluming, Design of aqueduct/ syphon aqueduct
6. Gravity Dams: Types of storage head works , Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam
7. Earth dams: Types of earth dams, Causes of failure of earth dams, Seepage analysis, Seepage control, Stability analysis
8. Spillways and energy dissipation systems: Types of spillways, Design of Ogee spillway, Design of stilling basins

Reading:

1. Modi, P. M., 2000, Irrigation Water Resources and Hydropower Engineering, Standard Book Publishing Company, New Delhi.
2. Arora, K. L., 1996, Irrigation Water Resources Engineering, Standard Book Publishing Company, New Delhi.
3. Asawa, G. L., 1996, Irrigation Engineering, New Age International Publishing Company, New Delhi.
4. Murthy, C. S. N., 2002, Water Resources Engineering – Principles and Practice, New Age International Publishing Company, New Delhi

CE353	ENVIRONMENTAL ENGINEERING - II	PCC	3-0-0	3 Credits

Pre-requisites: CE306 - Environmental Engineering I

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

CO1	Analyze characteristics of wastewater and solid waste and interpret their importance
CO2	Assess wastewater generated and design conveyance elements of wastewater collection systems
CO3	Plan and design components of wastewater treatment systems
CO4	Design sludge treatment and disposal systems
CO5	Identify elements of municipal solid waste management and plan suitable engineering systems for treatment and disposal

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	2	1	1	2	1	1	-	-	-	1	-	-	-	-
CO2	3	2	3	1	1	1	1	1	-	-	-	1	-	-	2	-
CO3	3	3	3	1	1	1	1	1	-	-	-	1	-	-	3	-
CO4	3	3	3	1	1	1	1	1	-	-	-	1	-	-	3	-
CO5	2	1	2	-	1	2	1	1	-	-	-	1	-	-	2	-

Detailed Syllabus:

1. Quality and Quantity Perspectives of wastewater: Physical, chemical and biological characteristics of wastewater, analysis of wastewater, Importance of BOD and COD, Effluent standards, impacts of disposal,
2. Sewers and sewer appurtenances: Wastewater Collection, Estimation of dry weather flow and storm water flow, Hydraulic design of sewers, Limiting velocities, effect of variation in flow of sewage on velocity of flow in sewers, types of sewers, design of storm water drains. Construction of sewers: factors affecting the selection of material for sewer construction, materials for sewers, joints in sewers, shapes of sewers, maintenance, cleaning & ventilation of sewers. Sewer appurtenances.
3. Primary Treatment of wastewater: Preliminary & primary treatment of wastewater: screening, grit removal basins, removal of oil and grease, sedimentation, sedimentation aided with coagulation.
4. Secondary Treatment of wastewater: Secondary treatment of Wastewater: Principles and classification of secondary treatment, activated sludge process, trickling filters, miscellaneous methods such as oxidation ditch, oxidation ponds, aerated lagoons, rotating biological contractors. Disposal of wastewater, self-purification of streams, sewage irrigation, Treatment and disposal of sludge, On-site disposal methods
5. Tertiary Treatment of wastewater: Tertiary wastewater treatment, necessity and principles, Industrial wastewaters and effluent treatment plants including institutional and industrial waste management.
6. Municipal Solid Wastes: Characteristics of MSW, Elements of solid waste management, engineered systems for solid waste management, Disposal of MSW, Hazardous waste, Biomedical and e-waste disposal.

Reading:

1. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous (1985), Environmental Engineering, McGraw Hill Inc., New York.
2. P.N. Modi (2008), Sewage treatment & Disposal and waste water Engineering – Environmental Engineering (Vol.II) – Standard Book House.
3. S.K. Garg (1999), Sewage Disposal and Air Pollution Engineering – Environmental Engineering (Vol.II) – Khanna Publishers.
4. Metcalf & Eddy, Inc. (2003), Waste water Engineering Treatment and Reuse, McGraw Hill Inc., New Delhi.

5. Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993
6. Nicholas P. Cheremisinoff (2002), Handbook of Water and Wastewater Treatment Technologies, Butterworth- Heineman.
7. CPHEEO Manual on sewarage and sewage treatment systems, 2013
8. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, 3rd Ed., WEF Press and McGrawHill, 2008

CE354	TRANSPORTATION ENGINEERING-II	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Identify the factors governing design of railway infrastructures
CO2	Analyze the railway track system and signal system with the available methods
CO3	Analyze the effects of atmospheric variables on aircraft performance and fix the orientation of the runways
CO4	Prepare geometric and structural designs of airfield infrastructure
CO5	Plan and design harbour facilities
CO6	Discriminate harbour works, berthing structures and transit sheds

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	1	1	-	1	1	-	-	-	-	1	1	2	3	1
CO2	3	3	1	2	-	1	1	-	-	-	-	1	2	1	3	-
CO3	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	2
CO4	3	3	3	3	2	2	2	-	-	-	-	1	-	1	3	-
CO5	3	3	3	2	3	1	1	-	-	-	-	1	1	-	3	2
CO6	3	1	1	1	-	1	1	-	-	-	-	1	-	-	1	-

Detailed Syllabus:

1. Geometric design of railway track: permanent way, forces acting, rails, sleepers and ballast, elements of junctions and layouts, types of traction, locomotives and other rolling stock, resistance due to friction, wave action, wind, gradient, curvature, tractive effort of a locomotive, hauling power of a locomotive; right of way and formation, field investigation, geometric design elements, safe speed on curves, speeds computation, string lining of curves, gradients, grade compensation, railway cant and cant deficiency.
2. Railway Station and Yards: objectives and classification of signaling and interlocking, fixed and stop signals, signaling systems, systems for controlling train movement, interlocking; site selection for railways station and yards, facilities, classification, platforms, building

areas, types of yards, sidings, foot over bridges, subways, loading gauge, end loading ramps, locomotive sheds, water columns, turntable, triangles, traverse, carriage washing platforms, buffer stop, scotch block, derailing switch, sand hump, fouling mark.

3. Aircraft and Airfield components: landing gear configurations, aircraft weight, engine types; atmospheric conditions affecting aircraft performance: air pressure, temperature, wind speed and direction; aircraft performance characteristics: speed, payload and range, runway performance, declared distances, wingtip vortices; air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation; air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation; navigational aids: ground based systems, satellite based systems; airport classification; passenger terminal system and its components; aircraft parking type, apron layout; approach lighting system configurations, visual approach slope aids, threshold lighting, runway lighting, taxiway lighting, runway and taxiway marking, airfield signage.
4. Geometric and Structural Design of the Airfield Infrastructure: runway configurations, runway orientation, wind rose, estimating runway length; exit taxiway geometry, location of exit taxiways, design of taxiway curves and intersections, end-around taxiways; Aprons: holding aprons, terminal aprons and ramps flexible and rigid pavement design using FAARFIELD.
5. Harbour Works: requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, 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, design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.
6. Docks and Sea Port Facilities: harbor 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; port development, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, inland port facilities

Reading:

1. Satish Chandra and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.
2. Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. Planning and Design of Airports, Fifth Edition, McGraw-Hill, New York, USA, 2010.
3. Seetharaman, S. Dock and Harbour Engineering, Umesh Publications, New Delhi, India, 1999.
4. J.S. Mundrey, Railway Track Engineering, Fourth Edition, Tata McGraw-Hill Education Private Limites, New Delhi, 2010.
5. Rangwala, S.C. Railway Engineering, Charotar Publishing House, Anand, India, 2008.
6. Khanna, S. K., Arora, M. G., and Jain, S. S. Airport planning and Design, Sixth Edition, Nem Chand and Bros, Roorkee, India, 2012.

7. Kumar, V., and Chandra, S. Air Transportation Planning and Design, Galgotia Publications Pvt. Ltd., New Delhi, India, 1999.
8. Srinivasan, R. Harbour, Dock and Tunnel Engineering, Charotar Publishing House Pvt. Ltd., Anand, India, 2009.
9. Hasmukh P. Oza and Gautam H. Oza, Dock and Harbour Engineering, Sixth Edition, Charotar Publishing House Pvt. Ltd., 2011.

CE355	GEOTECHNICAL ENGINEERING-II	PCC	3-0-0	3 Credits

Pre-requisites: CE304 - Geotechnical Engineering – I

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

CO1	Determine the earth pressures on foundations and retaining structures
CO2	Analyze shallow and deep foundations
CO3	Calculate the bearing capacity of soils and foundation settlements
CO4	Understand soil exploration methods

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	1	-	3	-	-	-	2	-	-	-	2	-	2	2	2
CO3	3	3	-	1	-	-	-	-	-	1	-	-	-	-	2	2
CO4	2	1	-	3	-	-	-	2	2	2	-	2	-	3	-	2

Detailed Syllabus:

1. Lateral Earth Pressures: Lateral earth pressure theory, Different types of earth pressures, Rankine's active and passive earth pressures, pressure distribution diagram for lateral earth pressures against retaining walls for different conditions in cohesionless and cohesive soils, Coulomb's active and passive earth pressure theory, Culmann's graphical construction, Problems.
2. Bearing capacity of foundation: Bearing capacity – Basic Definitions, Factors affecting bearing capacity, Estimation of Bearing capacity by different methods, Analytical measures – Terzaghi's and Meyerhof methods and calculations, Field measures – SPT, CPT and Plate load tests.
3. Settlement of foundation: Settlement analysis – Types of foundation settlement, Components of settlements - their estimation, Allowable settlement values, Effects, Causes and remedial measures of total and differential settlements
4. Shallow foundations: Types of shallow foundations and choice, basic requirements, Significance of these foundations
5. Pile foundations: Classification and uses, Load carrying capacity calculations by different methods – static methods, dynamic methods, in-situ penetration tests, piles load test;

Negative skin friction; under reamed pile foundations; Pile groups – Necessity, Efficiency, Group capacity and settlements.

6. Well foundations; Types of casissons and their construction; Different shapes of wells, component parts and forces; Estimation of bearing capacity; sinking of wells and remedial measures for tilts and shifts.
7. Soil Exploration: Introduction and different methods – Direct methods, Semi-direct and Indirect methods; Sampling in soils and rocks; subsurface exploration program - Preparation of bore logs and preparation of exploration report

Reading:

1. Murthy V.N.S (2007): Soil Mechanics and Foundation Engineering – CBS publications, Delhi.
2. Das, BM (2009): Geotechnical engineering – Cengage learning, New Delhi.
3. Gopal Ranjan, Rao ASR (2000): Basic and applied soil mechanics – New age publication, Delhi.
4. Iqbal H Khan (2007): Geotechnical Engineering – Prentice Hall, Delhi

CE356	CIVIL ENGINEERING SOFTWARE LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Understand the need for software tools in analysis and design of Civil Engineering Systems
CO2	Identify the available open source software tools used for specific problems in Civil Engineering
CO3	Use the latest software tools for Modeling, Analysis and Design of Civil Engineering Systems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	2	2	3	-	-	-	2	3	2	-	-	-	2	3
CO2	-	-	2	-	2	-	-	-	1	2	1	-	-	1	2	2
CO3	-	-	2	2	3	-	-	-	2	1	2	-	-	2	2	3

Detailed Syllabus:

1. MATLAB - Applications
2. SAP: Structural analysis and Design
3. ETABS: Integrated Analysis, Design and Drafting of Building Systems.
4. Plaxis: Geotechnical modeling software
5. Civil 3D: Computer aided Drafting, used for all Civil Engineering Drawings
6. MxRoad Suite: Modeling software for Road & Highway design, Rehabilitation and Renewal
7. MIKE-SHE: Hydrologic and Hydraulic modeling

8. HEC-HMS: Hydrologic Modeling system
9. SWMM: Storm Water Management Model
10. SWAT: Soil and water Assessment Tool
11. EPANET: Hydraulic and water quality behavior of water distribution system
12. OPEN FOAM: Fluid flow Simulation and Analysis

Reading:

1. Software manuals

CE357	ENVIRONMENTAL ENGINEERING LABORATORY	PCC	0-1-2	2 Credits

Pre-requisites: None

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

CO1	Determine physical, chemical and biological characteristics of water and wastewater
CO2	Determine optimum dosage of coagulant
CO3	Determine break - point chlorination
CO4	Assess the quality of water and wastewater

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	1	2	-	1	-	-	-	-	-	1	2	-	2	-
CO2	1	1	1	2	-	1	-	-	-	-	-	1	1	-	2	-
CO3	1	1	1	2	-	1	-	-	-	-	-	1	1	-	2	-
CO4	2	2	2	2	2	1	-	-	-	-	-	1	2	-	2	-

Detailed Syllabus:

1. Determination of pH.
2. Determination of Conductivity.
3. Determination of Acidity of water.
4. Determination of Alkalinity of Water.
5. Determination of Chlorides.
6. Determination of Hardness of water.
7. Determination of Fluorides.
8. Determination of Available Chlorine in bleaching powder.
9. Conducting Break Point Chlorination Test.
10. Determination of Residual Chlorine.
11. Determination of Dissolved Oxygen.
12. Determination of Chemical Oxygen Demand.
13. Determination of Biochemical Oxygen Demand.
14. Conducting Jar test for determining optimum dosage of coagulant.
15. Determination of Total Solids, Total Dissolved Solids & Settelable Solids

Reading:

1. Standard methods for the examination of water and wastewater. (2012). 21st Edition, Washington: APHA.
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2002
3. Kotaiah, B., and Kumara Swamy, N., Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2007.

CE401	QUANTITY SURVEYING AND PUBLIC WORKS	PCC	1-2-0	3 Credits

Pre-requisites: None

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

CO1	Prepare quantity estimates for buildings, roads, rails and canal works
CO2	Calculate the quantity of materials required for civil engineering works as per specifications
CO3	Evaluate contracts and tenders in construction practices
CO4	Prepare cost estimates

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	-	3	-	-	-	-	3	1	3	3	3	-	2	-
CO2	-	2	-	-	3	-	-	-	3	1	3	3	-	-	3	-
CO3	-	3	-	-	-	-	-	-	3	2	2	1	-	2	2	2
CO4	-	3	-	-	3	-	-	-	2	2	2	3	-	2	2	3

Detailed Syllabus:

1. Introduction to estimates: Purpose of estimating; Different types of estimates - their function and preparation; Building estimates: Schedule of rates, Units of measurements, units of works; Road Estimates Volume of earthwork, Different methods, Earthwork for hill roads; Railway and canal works Estimates for a new track railway line; earthwork in canals.
2. Analysis of rates: Preparation for analysis of rates. Quantity of materials per unit rate of work, labour estimate.
3. Specifications: Necessity, types of specifications, specifications for different civil engineering materials.
4. Contracts: Essentials of contracts, types of engineering contracts advantages and disadvantages.
5. Tenders: tender forms, tender documents & notices time limits, necessity.
6. Valuation: Purpose, difference between value and cost, qualifications and functions of a valuer, scrap & salvage value, sinking fund, capitalised value.

Reading:

1. Chakraborti, M, Estimation, costing, specifications and valuation in civil engineering
2. National Halftone Co. Calcutta, 2005.
3. Dutta B.N., Estimation and costing in civil engineering: theory and practice UBS Publishers Distributors Ltd, 2006.
4. Birdie, G.S. - Estimation and costing in civil engineering Dhanpat Rai Publishing co. ltd.

CE402	CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT	PCC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Understand the roles and responsibilities of a project manager
CO2	Prepare schedule of activities in a construction project
CO3	Prepare tender and contract document for a construction project
CO4	Understand safety practices in construction industry
CO5	Identify the equipment used in construction

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	2	-	-	3	2	2	3	-	-	-	-	-	-	-	-
CO2	-	-	-	-	3	2	2	3	-	-	-	-	-	-	-	-
CO3	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	3	-	3	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

1. Importance of Project Management, Role of Project manager, Stakeholders in construction project, Different types of projects, similarities & dissimilarities in projects., Time, Scope & Money, Knowledge areas & Processes involved in construction projects, WBS of a major work, with examples, Planning, monitoring & executing, Planning, sequencing, scheduling, Bar Charts, Networks, CPM, PERT, Upgrading, Cash flow diagram, resource levelling & resource allocation, Crashing of project, Cost Optimization, Invoicing, Preparation of RA bill,
2. Safety in construction - Cost of Accidents - Safety norms - Safety aids
3. Estimation, Tenders & Contracts - EOI- Prequalification - Types of Contract - Terminology used.
4. Equipment for construction - Earthwork - Concreting - Bitumen - Hoisting etc.,
5. Construction Finances – decision making,
6. Construction of piles, Construction of Tunnels, Construction of cofferdams.

Reading:

1. Construction Project Management - Kumar Neeraj Jha - Pearson Publication - 2015
2. Puerifoy R.L. - Construction Planning Equipment & methods.
3. Punmia and Khandelwal K.K. - Project Planning and Control - Laxmi Publ. Delhi.
4. Mahesh Varma - Construction Planning and Equipment - Metropolitan Co.
5. Choudhary S. - Project Management - Tata McGraw Hill Publishing Company Limited, New Delhi.

CE411	INDUSTRIAL WASTE TREATMENT	DEC	3 – 0 – 0	3 Credits

Prerequisites: CE353 - Environmental Engineering II

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

CO1	Identify the characteristics of industrial wastewaters
CO2	Describe pollution effects of disposal of industrial effluent
CO3	Identify and design treatment options for industrial wastewater
CO4	Formulate environmental management plan

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	1	1	2	1	1	-	-	-	1	-	-	-	-
CO2	1	1	1	1	1	1	1	1	-	-	-	1	-	-	1	-
CO3	3	3	3	1	1	1	1	1	-	-	-	1	-	-	3	-
CO4	2	2	2	1	1	1	1	1	-	-	-	1	-	-	2	-

Detailed Syllabus:

1. Introduction: Wastewater Characteristics, Standards of Disposal, Treatment Objective and, Strategies, Layouts of Primary, Secondary and Advanced Treatment Units.
2. Design of Preliminary and Primary Treatment Operations: Screens, Grit Chambers, Skimming Tank, Primary and Secondary Sedimentation Tanks.
3. Biological Treatment Processes: Types, Kinetics of Plug Flow and Completely Mixed Systems.
4. Attached Growth Processes: Trickling Filters (Standard Rate, High Rate), Biofilters, Practices, Features and Design, Operational Difficulties and Remedial Measures, Rotating Biological Contactors.
5. Suspended Growth Processes: Activated Sludge Process, Modifications and Design Equations, Process Design Criteria, Oxygen and Nutrient Requirements - Classification and Design of Oxidation Ponds, Lagoons.

6. Sludge Treatment and Disposal: Sludge Thickening, Aerobic and Anaerobic Sludge Digestion Processes, Design of Digester Tank, Sludge Dewatering, Ultimate Disposal, Sludge Drying Beds, Other Methods of Sludge Treatment.

Reading:

1. Metcalf and Eddy, Wastewater Engineering - Collection, Treatment, Disposal and Reuse, McGraw Hill Pub. Co., 1995.
2. Nelson Leonard Nemerow, Industrial Waste Treatment, Butterworth-Heinemann, 2007.
3. Benefield L.D. and Randall C.D. Biological Process Designs for Wastewater Treatment, Prentice Hall Pub. Co., 1980.

CE412	AIR POLLUTION	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Identify sampling and analysis techniques for air quality assessment
CO2	Describe the plume behaviour for atmospheric stability conditions
CO3	Apply plume dispersion modelling and assess the concentrations
CO4	Design air pollution controlling devices

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	2	2	1	1	-	-	-	1	1	-	1	1
CO2	2	2	1	1	3	1	1	1	-	-	-	1	1	-	1	1
CO3	3	3	2	1	3	2	1	1	-	-	-	1	1	-	2	3
CO4	2	3	3	2	2	2	1	1	-	-	-	1	1	-	3	-

Detailed Syllabus:

1. Air Pollution: Definition of Air Pollution - Sources & Classification of Air Pollutants - Effects of air pollution - Global effects - Air Quality and Emission standards - Sampling of Pollutants in ambient air - Stack sampling
2. Meteorology and Air Pollution: Factors influencing air pollution, Wind rose, Mixing Depths, Lapse rates and dispersion - Atmospheric stability, Plume rise and dispersion, Prediction of air quality, Box model - Gaussian model - Dispersion coefficient - Application of tall chimney for Pollutant dispersion.
3. Control of Particulate Pollutants: Properties of particulate pollution - Particle size distribution - Control mechanism - Dust removal equipment - Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & ESP.

4. Control of Gaseous Pollutants: Process and equipment for the removal by chemical methods - Design and operation of absorption and adsorption equipment - Combustion and condensation equipment.

Reading:

1. Colls, J., Air Pollution: Measurement, Modeling and Mitigation, CRC Press, 2009.
2. Noel, D. N., Air Pollution Control Engineering, Tata McGraw Hill Publishers, 1999.
3. Stern, A.C., Fundamentals of Air Pollution, Academic Press, 1984.

CE413	PRESTRESSED CONCRETE	DEC	3-0-0	3 Credits

Pre-requisites: CE302 - Design of concrete structures

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

CO1	Understand the concepts of pre-stressing in concrete structures and identify the materials for pre-stressing
CO2	Analyse a Pre-stressed Concrete section
CO3	Estimate losses of pre-stressing
CO4	Design pre-tensioned and post tensioned girders for flexure and shear
CO5	Design continuous pre-tensioned and post tensioned beams

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	-	-	-	1	-	1	-	-	1	-	-	2	1	-
CO2	-	3	1	-	-	1	-	1	-	-	1	-	-	-	3	1
CO3	1	2	3	-	-	1	-	1	-	-	1	-	-	-	2	-
CO4	-	1	3	2	-	1	-	1	-	-	1	-	-	-	3	-
CO5	-	-	2	3	-	1	-	1	-	-	1	-	-	-	3	-

Detailed Syllabus:

1. Introduction: Fundamentals of prestressing - Classification and types of prestressing- Concrete Strength and strain characteristics - Steel mechanical properties - Auxiliary Materials like duct formers.
2. Prestressing Systems: Principles of pretensioning and post tensioning - study of common systems of prestressing for wires strands and bars.
3. Losses of Prestress: Losses of prestress in pre tensioned and post tensioned members - I.S. code provisions.
4. Analysis of Sections: In flexure, simple sections in flexure, kern distance - cable profile - limiting zones - composite sections cracking moment of rectangular sections.

5. Design of Simply Supported Beams: Allowable stress as per I.S. 1343 - elastic design of rectangular and I-sections.
6. Shear and Bond: Shear and bond is prestressed concrete beams - conventional design of shear reinforcement - Ultimate shear strength of a section - Prestress transfer in pretensioned beams-Principles of end block design.

Reading:

1. Krishna Raju. N "Prestressed Concrete", Tata Mc Graw Hill.
2. Lin.T.Y, "Prestressed concrete", Mc Graw Hill Pub. Co.
3. Rajagopalan, "Prestressed concrete", Narosa Publishing House

CE414	APPLIED STRESS ANALYSIS	DEC	3-0-0	3 Credits

Pre-requisites: CE201 - Strength of Materials; MA211 - Mathematical Methods

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

CO1	Apply principles of elasticity theory to determine stresses and strains
CO2	Apply theory of elasticity and formulate plane stress and plane strain problems
CO3	Formulate the stress analysis problems using elasticity theory
CO4	Apply experimental techniques to solve field problems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	-	2	-	-	-	1		2		1	-	2	1	-
CO2	2	-	-	2	-	-	-	1		2		2	-	2	1	-
CO3	2	2	-	2	-	-	-	1	1	1		1	-	2	1	1
CO4	2	3	-	1	-	-	-	1	2	2		2	-	1	2	2

Detailed Syllabus:

1. Introduction to Theory of Elasticity, Assumptions made in strength of materials and theory of Elasticity, Necessary and sufficient conditions for analyzing a structure, State of stress at a point, Specification of stress at a point-Determination of Normal thrust and Shear stress, Problems on Specification of stress at a point.
2. Concept of Orthogonal Transformation of axes and Problems, Determination of Stress invariants, Determination of Principal Stresses and Planes, Determination of Maximum Shear Stresses and their corresponding planesystems, Tresca's criteria.
3. Derivation of Equilibrium conditions in three dimensions, Concept of Strain at a point, Determination of Normal and Shear Strain, Generalized Hooke's Law and problems on interrelationship between stress and Strain in three dimensions, Formulation of a stress analysis problem using the necessary and sufficient conditions in three dimensions and modifying the same to identify the unknowns in plane cases, Derivation of Airy's Stress function using the boundary conditions, equilibrium equations, compatibility conditions.

4. Solution to stress analysis problems, Torsion of circular shafts, Strain Measurement- Types of Strain gauges, Characteristics of ideal strain gauges, gauge factor, Strain gauge-Rosettes, Introduction to two dimensional photo elasticity, Stress-Optic law.

Reading:

1. Timoshenko and Goodier, Theory of Elasticity, 3rd Ed., McGraw Hill 2010.
2. J.W. Dally and W.F.Riley, Experimental Stress Analysis, 3rd Edition, Mc Graw Hill 1991

CE415	FOUNDATION ANALYSIS AND DESIGN	DEC	3-0-0	3 Credits

Pre-requisites: CE256 - Engineering Geology; CE355 - Geotechnical Engineering–II

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

CO1	Understand the behavior of problematic soil
CO2	Design foundations on expansive soils
CO3	Analyze the lateral stability of piles and wells
CO4	Evaluate design parameters for dynamic loading

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	3	2	-	2	2	1	-	2	2	3	2	3	-	3
CO2	1	2	2	3	-	2	2	2	-	2	2	3	2	-	2	2
CO3	1	2	2	3	2	2	-	1	-	2	2	2	-	-	2	-
CO4	1	2	-	2	2	2	-	1	2	2	3	2	2	1	1	2

Detailed Syllabus:

1. Problematic soils: Different types of problematic soils – Soft Clays, Loose Sands, Expansive soils, Erodible soils and Collapsible soils, Identification, categorization and problems associated with these soils, Geotechnical remedies for rectification of damage potential of these soils.
2. Expansive soils: Identification and characteristics of Expansive soils, Free swell index and swell potential, Swell pressure – Factors –Test, Effect of swelling on building foundations, Fundamental design in expansive soil – CNS layer, Under reamed pile and other concepts, Problems.
3. Shallow foundations: Individual footings, Combined Footings and Mat/Raft foundations - Computation of loads – Design steps – Proportioning of footings, Bearing capacity and settlements of foundations, Types of rafts – Conventional methods of design (Rigid beam analysis), Beams on Elastic foundations, Problems.
4. Pile foundations: Pile behavior under axial loads (piles under compression) – Review uplift capacity / resistance of piles (piles under tension), Lateral load capacity/ Resistance of piles, Winkler's hypothesis – Differential equations, Brom's solution for laterally loaded vertical piles in sand and clay, IS Code method, Problems.
5. Well foundations: Introduction – types and shapes of Caissons – Grip length, Estimation of bearing capacity and settlement of well foundation, Design of various

elements/components of well foundation, Forces acting on well foundation, Lateral stability of well foundations by IRC method, Problems.

6. Soil Dynamics and Machine foundations: Introduction, Fundamentals of vibration and soil dynamics, Types of Machines and Foundations, General requirements, Foundations of Reciprocating and Impact Machines, Vibration isolation and screening - Introduction, force isolation, motion isolation, screening of vibrations by use of open trenches, passive screening by use of pile barriers, problems.

Reading:

1. Murthy V.N.S (2007): Soil Mechanics and Foundation Engineering – CBS publications, Delhi.
2. Das, BM (2009): Geotechnical engineering – Cengage learning, New Delhi.
3. Gopal Ranjan, Rao ASR (2000): Basic and applied soil mechanics – New age publication, Delhi.
4. "Handbook of Machine Foundations" Srinivasulu, P. And Vaidyanathan, C. V., Tata McGraw-Hill, New Delhi, 2001
5. "Foundations for Machines, Analysis and Design" Prakash Shamsher and Puri Vijay K, John Wiley and Sons, USA, 1988.

CE416	GROUND IMPROVEMENT TECHNIQUES	DEC	3-0-0	3 Credits

Pre-requisites: CE256 - Engineering Geology; CE355 - Geotechnical Engineering–II

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

CO1	Identify ground conditions and suggest method of improvement
CO2	Design and assess the degree of improvement
CO3	Understand the principles of soil reinforcement and confinement in engineering constructions
CO4	Design reinforced soil structures

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	2	2	1	1	-	-	1	1	-	1	3	1	1	2
CO2	3	2	3	1	-	1	1	-	-	-	-	-	-	1	3	1
CO3	2	2	-	-	2	-	1	-	-	-	-	-	-	3	-	-
CO4	3	2	3	1	-	1	1	-	-	-	-	-	-	2	3	-

Detailed Syllabus:

1. Introduction: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility.
2. Mechanical Modification: Principles of Mechanical Modifications - Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic consolidation, precompression and compaction piles.

3. Hydraulic Modification: Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading with sand drains - strip drains, Design of vertical drains.
4. Physical and chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting – materials and methods.
5. Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Design of reinforcement for internal stability, Applications of Reinforced earth structures.
6. Ground Anchors and Soil Nailing: Types of ground anchors and their suitability, Uplift capacity of anchors; Soil nailing and Applications.
7. Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric form work.
8. Geotextiles: Overview on Geosynthetics – Geotextiles, Functions and Applications

Reading:

1. Manfred R. Haussmann - Engineering principles of ground modification – Pearson Education Inc. New Delhi, 2008.
2. Bell, F.G. – Engineering Treatment of Soils – E& FN Spon, New York, 2006.
3. Purushothama Raj, P “Ground Improvement Techniques” Laxmi Publications (P) Limited, 2006.

CE417	ADVANCED SURVEYING	DEC	0 – 1 – 2	2 Credits

Pre-requisites: None

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

CO1	Understand the basic principles of astronomical survey
CO2	Identify and correct errors in field measurements
CO3	Understand procedures of triangulation
CO4	Familiar with modern surveying principles, methods and instruments

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	1	3	1	3	2	2	1	1	1	2	1	1	1	1
CO2	2	3	2	2	2	2	1	3	2	2	1	2	1	1	1	1
CO3	2	3	2	2	1	1	1	2	2	2	1	2	3	3	3	1
CO4	3	2	2	1	1	1	2	1	3	1	2	3	1	1	1	1

Detailed Syllabus:

1. Astronomical Surveying: Astronomical coordinate systems, astronomical triangle, determination of azimuth.
2. Construction and Boundary Surveys: Equipment for construction surveys, Setting out pipe line,

setting out buildings and structures, setting out a highway,

3. Theory of Errors: Types and sources of errors, theory of least squares, method of weights, method of correlates, angle and station adjustment, figure adjustment.
4. Land Surveys: Layouts, Measurements.
5. Triangulation and Baseline Measurements: Triangulation figures or systems, station marks, signals, towers, Baseline measurement by rigid bars, flexible apparatus, problems, satellite station and reduction to centre.
6. Total Station and GPS: Basic principles, classifications, applications, comparison with conventional surveying. Electromagnetic wave theory - electromagnetic distance measuring system - principle of working and EDM instruments, Components of GPS – space segment, control segment and user segment, reference systems, satellite orbits, GPS observations. Applications of GPS.

Reading:

1. Borden D. Dent, Jeffrey Troguson, Thomas W. Hodler, Cartography: Thematic Map Design, McGraw-Hill Higher Education, 2008.
2. Gopi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India, 2007.
3. Hoffman.B, H.Lichtenegga and J.Collins, Global Positioning System - Theory and Practice, Springer -Verlag Publishers, 2001.
4. Punmia B. C, Ashok K. Jain, Arun K. Jain, Higher Surveying, Laxmi Publications, 2005

CE418	TRAVEL DEMAND ANALYSIS	DEC	3-0-0	3 Credits

Pre-requisites: CE305 - Transportation Engineering-1

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

CO1	Estimate demand for urban travel
CO2	Design urban transportation network
CO3	Estimate demand for regional travel
CO4	Design regional transportation network

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	2	2	1	1	-	-	-	-	1	-	-	1	2
CO2	3	3	3	2	2	1	1	-	-	-	-	1	-	-	3	-
CO3	3	2	3	2	2	1	1	-	-	-	-	1	-	-	1	2
CO4	3	3	3	2	2	1	1	-	-	-	-	1	-	-	3	-

Detailed syllabus

1. Transportation Issues - Population, Urbanization and Migration, Findings of Commission on Urbanization Introduction to Urban Transportation Urban Issues, Travel Characteristics,

Concept of Region, Issues Related to Regional Transportation Planning, Methods of Delineation Regions.

2. Travel Demand - Trends, Overall Planning process, Long term Vs Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques.
3. Data Collection And Inventories - Collection of data – Organisation of surveys and Analysis, Study Area, Zoning, Screen Lines, Types and Sources of Data - Road Side Interviews - Home Interview Surveys - Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors - Accuracy Checks, Use of Secondary Sources, Economic data – Income – Population – Employment – Vehicle Owner Ship.
4. Four Stage Demand Forecasting - UTPS Approach.
5. Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates.
6. Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.
7. Mode Choice Analysis: Mode Choice Behaviour, Competing Modes, Mode Split Curves, Models and Probabilistic Approaches.
8. Traffic Assignment: Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Capacity Restraint Techniques, Reallocation of Assigned Volumes, Equilibrium Assignment, Diversion Curves.
9. Regional Travel Demand Estimation - Factors Affecting Goods and Passenger Flows, Use of Mathematical Models to Estimate Freight and Passenger Demand, Abstract Mode Models, Mode Specific Models, Direct Demand Models, IVF Models, IO Model.

Reading:

1. Jotin Khisty C, Transportation Engineering - An Introduction, Prentice Hall, Englewood Cliffs, New Jersey, 2004.
2. Kadiyali L.R., Traffic Engineering and Transportation Planning, Khanna Publication, N.D, 2011.
3. Papakostas. C.S., Fundamentals of Transportation Engineering, PHI Pvt. Ltd., New Delhi, 2003.
4. Subhash C. Saxena, A Course in Traffic Planning and Design, Dhanpath Rai and Sons, New Delhi, 1989.

CE419	TRAFFIC ENGINEERING AND DESIGN	DEC	3-0-0	3 Credits

Pre-requisites: CE305 - Transportation Engineering-1

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

CO1	Conduct traffic studies and estimate basic characteristics of traffic stream.
CO2	Analyze the traffic data and interpret the results.
CO3	Design the geometric elements for better traffic system.
CO4	Analyze and design uncontrolled and signalized intersection with collected data.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	-	-	2	-	1	-	-	-	-	1	-	-	1	2
CO2	3	3	-	2	2	1	1	-	-	-	-	1	1	-	3	1
CO3	3	3	3	2	3	1	1	-	-	-	-	1	-	-	3	-
CO4	3	3	3	3	2	2	2	-	-	-	-	1	1	-	3	1

Detailed syllabus

1. **Characteristics of Traffic System**: Human-vehicle-environment system, Fundamental parameters of traffic and relationships; Microscopic and macroscopic characteristics;
2. **Traffic Data Collection studies:** Traffic study components, types of data; Volume studies; Speed studies; Travel time and delay studies; Intersection studies, Pedestrian studies; Parking studies, Vehicle detection methods; Advanced methods: GPS, Instrumented Vehicles, Image Processing, Bluetooth, Infrared methods
3. **Highway Capacity Analysis:** Capacity and level of service concepts; Factors affecting capacity and LOS; Freeway and multi-lane analysis; Capacity of Urban arterials; Signalised intersections; Un-signalised intersections; US Highway Capacity Manual (HCM) and IRC standards, Indo-HCM standards.
4. **Design of unsignalised intersections**: At grade intersections types and their suitability, factors affecting design, data requirement, parameters selection, intersection controls, estimation of conflict points, uncontrolled intercession analysis, sight distance requirements, roundabouts and design methodologies, capacity of roundabouts, mini-roundabouts.
5. **Design of signalized intersections:** Warrants for signalization, saturation flow rate and capacity, estimation of amber time, design of all aspects of signal timings, LOS studies, estimation of queue length and control delay, signal coordination, channelization and its objectives, channelizing devices, design considerations, typical channelizing examples.
6. **Design of Interchanges**: Necessities of interchanges, classification and types of common interchanges, layouts of interchange, interchange warrants, interchange design elements,

spacing and design speed, design of ramps, ramp configurations, weaving at interchange, design examples.

7. **Design of parking facilities**: Parking and influencing factors, type of parking system, parking angles and aisle width, on-street parking design, design parameters, parking surveys and demand estimation, various parking layouts and vehicle circulation, design of off street parking facilities, types and layouts, design examples.

Reading:

1. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2011.
2. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Prentice Hall, 4th Edition, 2010.
3. Adolf D. May, Traffic Flow Fundamentals, Prentice Hall, 1990.
4. Chakroborty Partha, Das Animesh, Principles of Transportation Engineering, PHI Learning Pvt. Ltd., 1st Edition, 2009.
5. C. Jotin Khisty http://www.amazon.com/Transportation-Engineering-Introduction-3rd-Edition/dp/0130335606/ref=sr_1_1?s=books&ie=UTF8&qid=1339240659&sr=1-1 ,
6. B. Kent Lall, Transportation Engineering: An Introduction, Prentice Hall; 3rd Edition, 2003.
7. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles Of Highway Engineering And Traffic Analysis, Wiley India Pvt Ltd., 4th Edition, 2011.
8. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2011.
9. Louis J. Pignataro and Edmund J. Cantilli, Traffic Engineering: Theory and Practice; Prentice hall, Inc., 1973.
10. Mike Slinn, Paul Matthews, Peter Guest, Traffic Engineering Design: Principles and Practice, Butterworth-heinemann, 2nd Edition, 2005.
11. Nicholas J. Garber, Lester A. Hoel, Nicholas J. Garber, Lester A. Hoel, Principles of Traffic and Highway Engineering, Cengage Learning India, 2nd Edition, 2010.
12. TRB Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.

CE420	SYSTEMS ANALYSIS IN CIVIL ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MA211-Mathematical Methods.

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

CO1	Formulate and solve deterministic optimization models
CO2	Apply deterministic optimization techniques for resource allocation, scheduling, inventory control, capacity expansion and transportation problems
CO3	Apply decision theory and stochastic optimization techniques for decision making under uncertainty
CO4	Formulate and solve optimization models for planning and design of civil engineering systems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2	3	2	-	1	-	-	-	1	1	1	-	2	-
CO2	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	-
CO3	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	2
CO4	3	3	3	3	3	-	1	-	-	-	1	1	1	-	3	2

Detailed Syllabus:

1. Modeling Techniques: Concepts of Systems Engineering, Types of mathematical models, Formulation of a prescriptive model, Overview of optimization techniques, Linear Programming, Graphical method, Simplex method, Sensitivity analysis, Dual LP, Transportation problem, Assignment problem, Integer Linear Programming.
2. Dynamic Programming: Concepts of dynamic programming, Formulation of recursive equation, Resource allocation using DP, Capacity expansion, Inventory control.
3. Nonlinear Optimization: Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, steepest gradient technique and other gradient based search techniques, Overview of genetic algorithm.
4. Decision Theory: Decision analysis, Decision making under risk and uncertainty, Markovian decision process, stochastic inventory control.
5. Simulation: Types of simulation models, Monte-Carlo simulation, Applications of simulation
6. Other Optimization Techniques.
7. Overview of Multi Objective Optimization Techniques, Fuzzy Optimization and Fuzzy Decision Making .

Reading:

1. Charles S. Revelle, E. Earl Whitlatch and Jeff R. Wright., Civil and Environmental Systems Engineering Pearson Education Inc., New Jersey, 2004.
2. Hiller, F. S. and Lieberman, G. J., Operations Research, CBS Publishers and Distributors, 2010.
3. Taha, H. A., Operations Research, Prentice Hall India, 2008.

CE421	IRRIGATION MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE352 - Irrigation Engineering

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

CO1	Plan irrigation systems and command area development programs
CO2	Evaluate the performance of an irrigation system
CO3	Plan measures for reclamation of water logged lands
CO4	Develop strategies for conflict management in irrigation projects

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	3	2	3	1	2	-	-	-	1	1	1	-	3	2
CO2	2	3	3	3	2	2	1	-	-	-	1	1	1	-	3	-
CO3	2	3	3	2	2	1	1	-	-	-	1	1	1	-	3	-
CO4	2	3	3	2	2	2	2	-	-	-	1	1	1	-	3	3

Detailed Syllabus:

1. Introduction – Need for proper management of land and water resources.
2. Planning of irrigation projects – Inadequacies in present approaches in canal irrigation management – command area development programmes.
3. Classification of irrigable soils – soils-plant-water relationships – soil management.
4. Irrigation management – Irrigation Management Matrix – Society and irrigation – perceptions of various stake holders on irrigation system performance.
5. Livelihood and Production Thinking Philosophy – the different approaches.
6. Macro and precision irrigation.
7. Water logging and salinity – water quality for irrigation – Reclamation of salt affected soils - Participatory irrigation management – Farmer's management of irrigation system acts - conflict resolution.
8. Legal aspects in water sharing and management – PC-CP - case studies Introduction to Integrated Water Resources Management (IWRM).

Reading:

1. Asawa G.L, Irrigation Engineering, New Age Int., 2004.
2. Chambers R, Canal Management, Oxford IBH, 2002.
3. VVN Murthy (2003)," Land and Water Management Engineering", Kalyani Publishers.
4. Sharma RK and TK Sharma (2012), "Irrigation Engineering", S Chand.

CE422	DESIGN OF HYDRAULIC STRUCTURES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE352 - Irrigation Engineering.

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

CO1	Analyse and design gravity dams
CO2	Analyse and design earth and rockfill dams
CO3	Design spillways and energy dissipation structures
CO4	Design of penstocks and surge tanks

Mapping of course outcomes with POs & PSOs

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO2	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO3	3	2	3	1	1	1	2	-	-	-	-	1	2	-	3	2
CO4	3	2	3	1	1	1	2	-	-	-	-	1	1	-	3	2

Detailed Syllabus:

1. Introduction - Classification of dams, Gravity dams, Earth dams, Arch dam, Buttress dam, Steel dams, Timber dams, selection of site for dam, selection of type of dam, investigations of dam sites, Engineering surveys, Geological investigations, Types of hydropower plants, site selection for power plant, General arrangement of a hydropower project.
2. Principles of Design of Hydraulic Structures - Hydraulic structures on permeable foundations, Theories of subsurface floor, Khosla's method of independent variables, Exit gradient, Location of Hydraulic jump, water surface profiles, scour due to subsurface flow, Design Principles, Energy dissipation principles.
3. Gravity Dams - Types of storage head works, Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam, Finite Element Method, Design of gravity dam, joints in gravity dam, Galleries in gravity dam, Adits and shafts, Construction of gravity dam, Foundation Grouting, Instrumentation of gravity dams.
4. Earth dams - Types of earth dams, Causes of failure of earth dams, Seepage analysis, phreatic line, flow net construction, criteria for safe design of gravity dams, typical cross sections of earth dams, Stability analysis, Seepage control, design of filters.
5. Spillways and energy dissipation systems - Essential requirements of spillways, Required spillway capacity, component parts of spillway, Types of spillways, Design of Ogee spillway, Design of shaft spillway, Design of siphon spillway, Design of stilling basins. Hydropower structures - Storage power plant, Runoff River plant, Pumped storage plant, Water conveyance systems, Tunnels and Penstocks, Gates, Surge tanks, Power house layout.

Reading:

1. Golze, A. R., Handbook of Dam Engineering, Von Rostrand Reinhold Co., 1977
2. Sharma, H.D., Concrete Dams, CBIP Publication, 1998.
3. Siddiqui, I H, Dams and Reservoirs: Planning, Engineering, Oxford University Press, USA, 2009.
4. Novak, P., Moffat, A. I. B., Nalluri, C and Narayan, R., Hydraulic Structures, Taylor & Francis, 2006.

SM421	ENGINEERING ECONOMICS AND PROJECT APPRAISAL	HSC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Estimate project cost
CO2	Perform economic analysis of an engineering project
CO3	Evaluate alternate project proposals
CO4	Carryout life-cycle cost analysis of projects
CO5	Analyze the macro economic performance of the Nation
CO6	Sensitized to Macro economic environment

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1				1	1						1				2	
CO2				1	1						2				2	
CO3				1	1						2				2	
CO4				1	1						3				2	
CO5					1						3				1	
CO6					1						3				1	

Detailed Syllabus:

1. **Introduction to Engineering Economics:** Review of engineering economics, elements of engineering economics, valuation of time, goals and objectives, principles of economic analysis, Discounted cash flows: analysis of costs and benefits, methods of economic analysis; suitability, analysis for null alternative, mechanisms to deal with risks.
2. **Micro Economics:** Microeconomics, welfare theory. Consumer equilibrium, Consumer surplus and producer surplus, latent demand
3. **Macro Economics and Economic Policy**: Introduction to Macro Economic performance indicators (National Income, Inflation, BOP, Exchange rates) – Meaning, limitations, Economic Policy 1991, Liberalization, Privatization and Globalization.
4. **System selection and evaluation**: Framework of evaluation, Feasibility and evaluation, cost, impacts and performance levels project evaluation methods, achievement matrices, factor profiles, plan ranking, introduction to mathematical programming, case studies.
5. **Project appraisal:** Types of Projects – BOT, BOOT, PPP; Evaluation of alternatives, analysis techniques, cost benefit analysis, social and financial benefits, Internal Rate of return method for economic and financial viability, prioritization of projects, multi-criteria decision assessment, Life Cycle Cost Analysis, TQM Concepts and Principles.

Reading:

1. Chan S. Park, Fundamentals of Enginering Economics, Pearson Education Inc, 2004

2. Donald G. Newnan, Ted G. Eschenbach and Jerome P. Lavelle, Engineering Economic Analysis, 11th Edition, Oxford University Press, 2012

CE461	ENVIRONMENTAL MODELLING	DEC	3 – 0 – 0	3 Credits

Prerequisites: MA211-Mathematical Methods

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

CO1	Understand and apply the concepts of mass balance in various engineered systems
CO2	Assess pollutant transport using mass transport equations
CO3	Calculate the size of the Kolmogorov micro scale in sheared reactors
CO4	Estimate the fractal dimension of flocs in coagulation process and estimate the bulk density of the flocs based on the fractal dimension

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	1	1	1	1	1	1	-	-	-	1	-	1	1	1
CO2	3	3	2	2	3	2	1	1	-	-	-	1	-	2	2	1
CO3	1	2	2	1	1	1	1	1	-	-	-	1	-	-	2	-
CO4	3	3	2	2	3	1	1	1	-	-	-	1	-	2	2	-

Detailed Syllabus:

1. Basic concepts of mole and mass concentration: notations and conventions, Review of mass balance concepts.
2. Diffusive transport: Diffusion and Fick's first law, Calculation of molecular diffusion coefficients in air and water.
3. The constitutive transport equation: Derivation of general transport equation and special forms i.e. continuity and NS equations and similarity between equations of mass momentum and heat dispersion laws.
4. Theories of mass transport: two film theory, penetration and surface renewal theory, Boundary layer theory. Mass transport correlations.
5. Transport in sheared reactors: Fluid shear and turbulence, transport in steady sheared fluids, turbulent sheared fluids, and shear rates in mixed reactors.
6. Particles and fractals: Introductions, particle size spectra, solid particles and fractal aggregate geometries, measuring and calculating fractal dimensions from particle size distributions.
7. Coagulation in natural and engineered systems: Introduction, general coagulation equations, factors affecting the stability of aquasols, coagulation kinetics, fractal coagulation models.

Reading:

1. Environmental Transport Processes by Bruce E. Logan, 2nd Ed., Wiley, 2012.

2. Diffusion: Mass transfer in fluid systems by E.L. Cussler, 3rd Ed., Cambridge University Press, 2007.
3. Introduction to chemical transport in the environment by John S. Gulliver, Cambridge University Press, 2007.
4. Environmental Engineering: A Design Approach by Sincero and Gregoria, PHI Learning, 2009.

CE462	ENVIRONMENTAL IMPACT ASSESSMENT	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Identify the environmental attributes to be considered for the EIA study
CO2	Formulate objectives of the EIA studies
CO3	Identify the methodology to prepare rapid EIA
CO4	Prepare EIA reports and environmental management plans

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	1	2	1	2	3	-	-	-	-	1	1	1	2	-
CO2	1	2	1	1	1	2	3	-	-	-	-	1	1	1	2	-
CO3	2	3	2	3	2	2	3	-	-	-	-	1	1	1	2	-
CO4	2	2	2	2	1	2	3	-	-	-	-	1	1	1	2	-

Detailed Syllabus:

1. Introduction: The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.
2. Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection - Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.
3. EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or

Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

4. Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing, Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.
5. Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.
6. Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu. Y and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern. P Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

CE463	SOLID WASTE MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Identify the physical and chemical composition of wastes
CO2	Analyze the functional elements for solid waste management
CO3	Understand the techniques and methods used in transformation, conservation, and recovery of materials from solid wastes
CO4	Identify and design waste containment systems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	2	1	2	1	1	-	-	-	1	-	1	1	-
CO2	2	3	2	2	2	2	2	1	-	-	-	1	-	2	2	-
CO3	3	3	2	2	1	2	2	1	-	-	-	1	-	2	2	-
CO4	3	3	3	2	2	2	2	1	-	-	-	1	-	2	3	-

Detailed Syllabus:

1. Solid Waste: Definitions, Characteristics, and Perspectives; Types of solid wastes, sources of solid wastes, properties of solid wastes, solid waste management: an overview.
2. Engineering Systems for Solid Waste Management: Solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; processing techniques; ultimate disposal.
3. Engineering Systems for Resource and Energy Recovery: Processing techniques; materials-recovery systems; recovery of biological conversion products; recovery of thermal conversion products; recovery of energy from conversion products; materials and energy recovery systems.

Reading:

1. Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993.
2. Vesilind PA, Worrell W and Reinhart D, 'Solid Waste Engineering' Brooks/Cole Thomson Learning Inc., 2002.
3. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, 'Environmental Engineering', McGraw Hill Inc., New York, 1985.
4. Qian X, Koerner RM and Gray DH, 'Geotechnical Aspects of Landfill Design and Construction' Prentice Hall, 2002.

CE464	DESIGN OF EARTHQUAKE RESISTANT STRUCTURES	DEC	3-0-0	3 Credits

Pre-requisites: CE351 - Theory of Structures-II

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

CO1	Apply seismic coefficient and response spectrum methods for analysis of multi storied buildings
CO2	Apply concepts of ductility in the design of multi-storeyed structures
CO3	Analyse a water tank structure based on latest earthquake code
CO4	Understand the concepts of base isolation

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	2	3	-	-	1	-	1	-	-	1	-	-	-	2	3
CO2	-	-	3	2	-	1	-	1	-	-	1	-	-	-	3	1
CO3	-	2	3	1	-	1	-	1	-	-	1	-	-	-	3	1
CO4	-	-	2	3	-	1	-	1	-	-	1	-	-	-	2	-

Detailed Syllabus:

1. Elements of Earthquake Engineering: Earthquake magnitude and intensity, Focus and Epicentre, Causes and Effects of Earthquakes, Characteristics of Earthquake, Seismic zone mapping.
2. Structural Systems For Seismic Resistance: Structural systems – building configuration, frames, walls, dual systems – response in elevation – plan – influence of structural classification- Concepts of seismic design.
3. Analysis for Earth Quake Loads: IS: 1893-2002- Seismic Coefficient method- modal analysis- Applications to multi-storied building frames – water tanks – chimneys.
4. Ductile Detailing: Ductility of R.C structures- Confinement- detailing as per IS-13920-1993- moment redistribution – principles of design of beams, columns – beam column joints – soft story concept.
5. Base Isolation: Isolation systems – Effectiveness of base isolation.

Reading:

1. Dynamics of structures – A.K. Chopra, Prentice Hall.
2. I.S. 1893 - 2002, Criteria for Earthquake Resistance design of Structures.
3. Pankaj Agarwal and Manish Shrikhande, Earthquake resistant design of structures, PHI 2006.

CE465	ADVANCED REINFORCED CONCRETE DESIGN	DEC	3-0-0	3 Credits

Pre-requisites: CE302 - Design of Concrete Structures

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

CO1	Design cantilever and counterfort retaining walls
CO2	Design underground and elevated water tanks
CO3	Design bunkers and silos
CO4	Design reinforced concrete chimneys

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	2	-	-	1	1	-	-	1	-	-	-	2	-
CO2	2	2	-	2	-	-	1	1	-	-	1	-	-	-	2	-
CO3	1	2	1	2	-	-	-	1	-	-	1	-	-	-	2	-
CO4	-	2	1	-	-	-	1	1	-	-	1	-	-	-	2	-

Detailed Syllabus:

1. Principles of Cantilever and counterfort type retaining walls,
2. Detailed design of cantilever type of retaining walls,
3. Detailed Design of Grid Floors, Analysis and Design of Flat Slabs,
4. Design principles of underground and elevated water tanks,
5. Detailed design of rectangular and circular elevated water tanks as per IS 3370, Design of Ring Beam and staging for elevated water tanks,
6. Detailed Design of Intz Tanks,
7. R.C. Bunkers and Chimneys.

Reading:

1. N. Krishna Raju, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2007.
2. Punmia B.C. Ashok Kumar Jain and Arun K. Jain, RCC Designs(Reinforced Concrete Design), 10th Edition, Lakshmi Publishers, 2006

CE466	REPAIR AND REHABILITATION OF STRUCTURES	DEC	3-0-0	3 Credits

Pre-requisites: Concrete Technology, Design of Concrete Structures

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

CO1	Assess deterioration and deficiency in aging infrastructure
CO2	Apply Non Destructive Testing techniques to field problems
CO3	Suggest materials and techniques for repairing and rehabilitation of deteriorated concrete structures
CO4	Apply cost effective retrofitting strategies for repairs in buildings and bridges

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2	2	1	2	1	1	2	2	1	2	-	2	3	3
CO2	2	1	1	2	2	2	1	1	3	1	-	2	1	3	2	3
CO3	2	2	1	2	1	1	-	1	2	1	2	1	-	3	3	2
CO4	2	2	1	2	1	1	-	1	2	1	2	1	-	2	3	1

Detailed Syllabus:

1. Aging of infrastructure and performance of structures– need for rehabilitation.
2. Distress in concrete / steel structures – damage – source – cause – effects – case studies.
3. Damage assessment and Evaluation models – Damage testing methods – NDT – Core samples.
4. Rehabilitation methods – grouting – detailing – imbalance of structural stability – case studies.
5. Methods of repairs – shortcreting – guniting – epoxy – cement mortar injection – crack ceiling.
6. Repair and maintenance of buildings – IS standards – Bridge repairs – Seismic strengthening.

Reading:

1. Diagnosis and treatment of Structures in Distress – R N Raikar, R & D Centre, Structwel Designers & Consultants, 1994.
2. Concrete Bridge Practice: Construction, Maintenance and Rehabilitation, Shroff Publishers and Distributors Pvt. Ltd.; 1 edition (2005)
3. Building Failures – Diagnosis and Avoidance – W H Ranson, E. & F.N. Spon, 1981 – Technology & Engineering
4. Forensic Engineering – Kennethe and Carper, CRC Press, 2000

CE467	FINITE ELEMENT ANALYSIS	DEC	3-0-0	3 Credits

Pre-requisites: MA211 - Mathematical Methods

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

CO1	Develop shape functions and stiffness matrices different finite elements
CO2	Develop global stiffness matrices and global load vectors
CO3	Apply natural and arial coordinate systems to constant strain triangle and linear strain triangle elements
CO4	Analyze planar structural systems using finite element modeling

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	1	3	-	-	-	-	1	-	-	-	-	-	-	2	-
CO2	-	-	2	3	-	-	-	1	-	-	-	-	-	-	2	-
CO3	-	-	2	3	-	-	-	1	-	-	-	-	-	-	2	-
CO4	-	-	3	2	-	-	-	1	-	-	-	-	-	-	3	1

Detailed Syllabus:

1. Matrix Methods of Structural Analysis – Review of concepts – Actions and displacements – compatibility – indeterminacy – Member and joint loads – Flexibility Matrix formulation - Stiffness Matrix formulation.

2. Introduction to Finite Element Method – Background and general description of the method – summary of the analysis procedure.
3. Theory of Finite Element method - Discretisation concept- Concept of element – various elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure.
4. Finite Element Analysis - Development of shape functions for different elements-Spring-Truss-Beam-Plane elements- Plane stress and plane strain-Assemblage of elements construction of stiffness matrix and loads – boundary conditions –patch test-solution of overall problem.
5. Isoparametric Formulation -Concept of Isoparametric element – One and Two dimensional elements-Natural coordinates- Development of Higher order elements- Lagrange – Serendipity –Interpolation-formulation of element stiffness and loads.
6. Application to Solid Mechanics problems - Analysis of Trusses – Beams – Frames-Plates.

Reading:

1. Finite element analysis, theory and Programming by CS Krishna Murthy.
2. Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu.
3. The Finite element Method in Engineering, 5th edition by S.S.Rao

CE468	EARTHQUAKE GEOTECHNICAL ENGINEERING	DEC	3-0-0	3 Credits

Pre-requisites: CE355 - Geotechnical Engineering–II

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

CO1	Understand the earthquake mechanisms
CO2	Understand earthquake motion on soil properties and soil-structure interaction
CO3	Evaluate the seismic susceptibility of the ground
CO4	Design foundations, slopes and pavements for seismic loading

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	-	-	-	-	1	1	2	2	2	2	1	-	1	-
CO2	2	-	-	-	-	-	1	1	1	1	2	2	2	-	1	-
CO3	-	-	-	2	1	-	1	1	2	2	2	3	-	3	2	-
CO4	-	-	-	3	-	-	2	1	2	2	2	3	1	2	2	3

Detailed Syllabus:

1. Seismology and earthquakes**:** Basic earthquake principles: Introduction–Internal structure of earth–Plate tectonics faults–seismic waves–Seismograph–Classification of earthquakes–Magnitude and intensity of earthquakes- Seismic zones in India.
2. Common Earthquake effects: Surface rupture–Regional subsidence–liquefaction–slope movement –Tsunami and seiche.
3. Earthquake structural Damage: Earthquake induced settlement–Resonance of structures.

4. Soil dynamics: Dynamics of discrete system –Soil structure interaction–Vibratory system– free and forced vibration without and with damping–Base shaking–Dynamic soil properties– problems.
5. Geotechnical earthquake engineering analysis: Site investigation: Scope of investigation–
6. Quantitative evaluation–subsurface investigation–laboratory testing –peak ground acceleration - Report preparation–problems.
7. Liquefaction: Introduction–mechanism–laboratory liquefaction studies– factors that govern Liquefaction in the field–Liquefaction analysis–cyclic stress ratio from the SPT, DCPT and shear wave velocity-FS against liquefaction– Anti Liquefaction measures– problems.
8. Earthquake induced settlement: Introduction–settlement VS factor of safety against Liquefaction induced ground damage–volumetric compression –settlement due to dynamic loads caused by rocking–problems.
9. Bearing capacity analysis for earthquakes: Introduction– one third increases in bearing capacity pressure for seismic condition–Bearing capacity analysis for liquefied soil–granular soil with earthquake induced pore water–Bearing capacity analysis for cohesive soil weakened by the earthquake– problems.
10. Slope stability analysis for earthquake: Introduction–inertia slope stability: pseudo static method, newmark method–weakening slope stability: flowslides, liquefaction induced lateral spreading, strain softening soil–restrained retaining walls and temporary retaining walls– problems.
11. Other geotechnical earthquake engineering analysis: Introduction–pavement design– pipeline design–problems.
12. Site improvement methods to mitigate earthquake effects: Soil improvement Methods: Introduction–Grading, soil replacement, water removal, site strengthening, grouting, thermal, and ground water control methods.
13. Foundation analysis: Introduction – shallow and deep foundations.

Reading:

1. Kramer, S.L. (2003): “Geotechnical Earthquake Engineering”, Pearson Education.
2. Day, R. W.(2003): “Geotechnical Earthquake Engineering hand book”, McGrawHill.
3. Kamalesh Kumar, (2008): “Basic Geotechnical Earthquake Engineering”, New Age.
4. IS-1893 (part-1) 2002,“Criteria for Earthquake resistant design of structures” part1 - general provision of buildings.

CE469	APPLICATIONS OF GEOSYNTHETICS	DEC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Identify various Geosynthetic products and understand their manufacture
CO2	Identify the functions of geosynthetic products
CO3	Understand various applications of geosynthetics
CO4	Select the geosynthetic products for engineering works
CO5	Identify the testing methods for geosynthetics
CO6	Design geosynthetic products for various works

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	2	-	-	1	2	-	-	-	-	-	-	3	-	-
CO2	-	-	2	-	-	-	-	1	-	-	-	2	-	2	-	-
CO3	3	1	3	-	-	-	3	-	-	-	-	-	-	2	3	-
CO4	-	-	2	-	1	-	-	1	-	-	-	-	-	-	3	-
CO5	-	1	2	-	-	-	-	1	-	-	-	-	-	3	1	-
CO6	-	-	2	2	-	-	-	1	-	-	-	-	-	-	3	1

Detailed Syllabus:

1. Introduction: An overview on the development and applications various geosynthetics - the geotextiles, geogrids, geonets, geomembranes and geocomposites.
2. Designing with geotextiles: Manufacture of geotextiles, Overview of various polymers used, Geotextile properties and test methods – functions - Designing geotextiles for separation, reinforcement, stabilization, filtration and drainage.
3. Designing with geogrids: Manufacture of geogrids, Uniaxial and biaxial geogrids, Geogrid properties and test methods – physical properties, mechanical properties, endurance properties and environmental properties – Designing for grid reinforcement in pavements, Retaining walls and bearing capacity.
4. Designing with geonets: Manufacture of geonets, Geonet properties and test methods – Physical properties, mechanical properties, hydraulic properties, endurance properties and environmental properties -Designing geonet for drainage.
5. Designing with geomembranes: Geomembrane properties and test methods – physical properties, mechanical properties, chemical properties and biological hazard - Applications for geomembranes.
6. Designing with geocomposites: Geocomposites in seperation, reinforcement – reinforced geotextile composites – reinforced geomembrane composites – reinforced soil composites using discontinuous fibres and meshes, continuous fibres and three –dimensional cells, Designing for bearing capacity, geocomposites in drainage and filtration.

Reading:

1. Rao, G.V. and Goutam K. Pothal " Geosynthetics Testing – A laboratory Manual" Sai Master Geoenvironmental Services Pvt. Ltd. Hyderabad, 2008.
2. Sivakumar Babu G.L. "An Introduction to Soil Reinforcement and Geosynthetics" University Press, 2009.
3. Rao, G.V. – "Geosynthetics – an Introduction", Sai Master Geoenvironmental Services Pvt. Ltd. Hyderabad, 2011.
4. Koerner, R.M. – "Designing with geosynthetics", Pearson Education Inc., 2012.
5. Shukla, "An Introduction to Geosynthetics Engineering" CRC Press, 2017, Hyderabad.

CE470	ROCK ENGINEERING & UNDERGROUND STRUCTURES	DEC	3-0-0	3 Credits

Pre-requisites: CE304-Geotechnical Engineering I & CE355 - Geotechnical Engineering II

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

CO1	Classification of Rocks
CO2	Understanding of Engineering Properties of Rocks and Rock-Masses
CO3	Analysing the Differences and Similarities between Soil and Rock Mechanics
CO4	Evaluating the design parameters for structures such as tunnels, caverns, dam foundations

Mapping of course outcomes with program outcomes

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3		2	1												
CO2	1		2	3												
CO3	1		3		2											
CO4	1		2	3	3	2										

Detailed syllabus

1. **Geological considerations**: Geologic structures, faults, folds, joints, fissures, Igneous, Metamorphic and Sedimentary rocks. Rock structures.
2. **Introduction**: Rock materials, Physical properties, Strength behaviour in uniaxial compression, tension and tri-axial state. Laboratory investigations of rock testing methods. Stress-strain relationships.
3. **In-situ Testing of Rock mass**: Strength and deformation behaviour of discontinuities. Rock mass behaviour, Shear strength of jointed rocks, roughness, peak and residual strengths. Strength criteria for rock mass. Determination of modulus of deformation by Uni-axial Jack test, Plate jacking test, Goodman jack test, Flat jack test, Cable jacking test, Radial jack test and Dilatometer test. Pull out tests. packer tests for in-situ permeability, Codal provisions.
4. **Intact and Rock mass classifications**: Terzaghi, Rock Quality Designation (RQD), Rock Mass Rating (RMR), tunnel Quality Index (Q- System) classification, Rating, Applications.
5. **In-situ Stresses**: Hydraulic Fracturing technique, Hydraulic Tests on Pre-existing Fractures (HTPF), Surface Relief Methods, Under Coring, Borehole Relief Methods (Over coring, Borehole Slotting), Relief of Large Rock Volumes (Bored Raise, Under Excavation Techniques, Flat Jack Method, Curved Jack Method, Borehole Televiewer Analysis.
6. **Application of rock mechanics to underground structures**: Types and classification of underground openings, Factors affecting design. Design methodology. Functional aspects. Size and shapes. Support systems and codal provisions.

7. **Analysis**: Stresses and deformations around openings, Stresses and deformations around tunnels and galleries with composite lining due to internal pressure, Closed form solutions, BEM, FEM.
8. **Design** : Design based on analytical methods; Empirical methods based on RSR, RMR, Q systems; Design based on Rock support interaction analysis

Reading:

1. Bieniawski, Z.T.. Engineering Rock Mass Classifications. John Wiley and Sons, 1989.
2. Brady B.H.G. and Brown E.T. Rock Mechanics for Underground Mining, Kluwer Academic Publishers, 2005
3. Goodman R.E., Introduction to Rock Mechanics, John Wiley and Sons, New York, 1989.
4. Hoek, E., Brown, E. Underground excavations in rock, CRC Press, 1980.
5. Hudson, J.A. (1989), Rock Mechanics Principles in Engineering Practice, CIRIA, Butterworth & Co, London.
6. Ramamurthy T., Engineering in Rocks for Slopes, Foundations and Tunnels, PHI Learning Pvt. Ltd. 2010.
7. R.J.Twiss and E.M.Moores Structural Geology, W.H.Freeman and Co,2007.
8. Zhang Lianyang. Engineering Properties of Rocks. Elsevier, 2005.

CE471	GLOBAL NAVIGATION SATELLITE SYSTEM	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify GNSS components and their functions
CO2	Select GNSS survey method
CO3	Interpret the navigational message and signals received by the GNSS
CO4	Identify error sources in GNSS observations, and apply the corrections for accurate positioning
CO5	Map the geospatial features

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	2	2	2	3	2	2	3	2	3	1	2	1	2	1
CO2	2	2	3	1	3	2	2	3	2	2	2	1	2	1	2	1
CO3	1	3	2	3	2	1	1	2	2	2	1	2	1	1	1	1
CO4	2	2	1	2	1	1	2	1	1	1	2	2	1	1	2	1

Detailed Syllabus:

1. Geodesy: Introduction: History of GNSS;Various positioning systems, Global and regional systems

2. GLONASS system- Services and Segments
3. Galileo System- Services and Segments
4. Regional Navigation Satellite Systems (RNSS), Augmentation Systems
5. Reference Systems and Coordinate systems: Definition and scope of Geodesy, Earth Indian Geodetic System and Everest Spheroid, WGS 84, Geodetic coordinate systems Datum transformations, Height systems, Time systems
6. Satellite Observables: Pseudo range measurements, Atmospheric effects, Antenna phase center offset and variation, Multipath, system accuracy characteristics, Data formats, Error budget
7. Surveying with GNSS: Planning a GNSS Survey, Positioning methods – point positioning, relative positioning, Static, Differential, RTK
8. Accuracy measures, software modules, GIS and GNSS data integration
9. Applications of GNSS

Reading:

1. Bradford W. Parkinson & James Spilker., Global Positioning System: Theory and Applications, Vol I,1996
2. Hofmann-Wellenhof, Lichtennegger and Wasle., GNSS: Global Navigation Satellite Systems, Springer-Verlag Wein, New York, 2008.
3. Gunter Seeber., Satellite Geodesy Foundations-Methods and Applications,2003.
4. ShuanggenJin, EstelCardellachadnFeiqinXie., GNSS Remote Sensing: Theory, Methods and Applications, Springer, London, 2014.

CE472	GIS - APPLICATIONS IN CIVIL ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze geospatial data for solving problems of natural and anthropogenic systems
CO2	Preparation of geospatial features in computing environment
CO3	Create GIS and cartographic outputs for presentation
CO4	Apply the geospatial skills in implementing a GIS Project

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	-	-	2	2	2	-	1	1	-	1	3	-	2	1
CO2	3	2	2	1	3	2	2	-	1	1	1	1	3	-	2	2
CO3	2	1	3	2	3	2	2	-	2	3	2	2	2	-	2	2
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	2	2	2

Detailed Syllabus:

1. Introduction – GIS definition, development, application areas.
2. Map Concept- Map-Definition, Elements of Maps, Types of maps, Advantages and disadvantages of analog/digital maps, Coordinate Systems- Geometric models of earth, Global/Local coordinate system, Projection Systems- Classification, Cylindrical projection, Conical projection, Selection of a

particular projection.

3. Fundamental concepts of GIS – Modeling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data,
4. Database preparation and editing- Data collection and Input, Data conversion, Hardware & software Requirements, Topology – Editing and Error Rectification, Types of topology, Topological Relationships.
5. Spatial Analysis – Buffer Analysis-Variations in Buffering, Applications of buffering, Overlay Analysis-Feature type and overlay, Vector Overlay methods, Network Analysis-Impedance, Shortest path analysis, closest facility, Concepts of Proximity analysis, Neighborhood operations, DEM and TIN.
6. GIS Project Planning – Steps in GIS project, Problem Identification and Implementation of a GIS project.
7. GIS Applications – Transportation, Water Resources, Environment, Geology, Emergency Management, Agriculture, Urban planning, climate change, Business.
8. Advances in GIS – Concepts and application of open source Mobile and Web GIS.

Reading:

1. C.P. Lo, Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt. Ltd, New Delhi, 2009.
2. Kang-Tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2015.
3. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2016.

CE473	HIGHWAY CONSTRUCTION AND MAINTENANCE	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE354 - Transportation Engineering-1

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

CO1	Select appropriate earth moving and compaction equipment depending upon the requirement.
CO2	Prepare quality assurance and quality control plans in an attempt to construct better performing pavements.
CO3	Evaluate the pavements based on the functional and structural characteristics.
CO4	Evaluate the safety aspects of the pavements specifically in terms of friction and other related distresses.
CO5	Select maintenance technique depending upon the intensity of the distresses.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	-	-	3	-	1	-	-	-	-	1	-	-	1	1
CO2	3	1	1	2	1	1	-	-	-	-	-	1	-	2	1	1
CO3	3	3	1	3	3	1	-	-	-	-	-	1	-	1	2	1
CO4	3	3	1	3	3	1	-	-	-	-	-	1	-	1	2	3
CO5	3	1	-	2	1	2	2	-	-	-	-	1	-	1	2	-

Detailed syllabus

1. Highway Construction Equipment: applications and safety aspects of earth moving equipments, compaction equipments, road making equipments, concreting equipments and paving equipments.
2. **Pavement Construction:** construction and preparation of subgrade soil, construction of sub-base layer, construction of base layer, construction of bituminous surface layers, construction of cement concrete surface layer and MoRT&H specifications.
3. **Functional Evaluation of Pavements:** introduction, factors affecting pavement deterioration, functional condition evaluation techniques, roughness measurements, Identification of uniform sections, serviceability concepts, visual and ride rating techniques.
4. **Structural Evaluation of Pavements:** structural condition evaluation techniques, NDT procedures, rebound deflection, deflection bowl measurement and analysis, IRC overlay design method, structural evaluation using falling weight deflectometer, back calculation of layer moduli, ground penetrating radar for pavement evaluation, evaluation of pavement safety, skid resistance and hydroplaning.
5. **Pavement Maintenance:** routine maintenance, periodic maintenance, special repairs, responsive maintenance programme, rehabilitation and reconstruction, treatment strategies and selection.

Reading:

1. David Croney and Paul Croney, The Design and Performance of Road Pavements, Third Edition, McGraw-Hill Professional, 1997.
2. Haas, R., W.R. Hudson and J.P. Zaniewski. Modern Pavement Management, Krieger Publishing Company, Malabar, Florida, USA, 1994.
3. Ministry of Road Transport and Highways. Specifications for Road and Bridge Works, Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.
4. Papagiannakis, A.T. and E.A. Masad Pavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008.
5. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press, London, 2013.

CE474	NON MOTORIZED TRANSPORT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Transportation Engineering-1

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

CO1	Quantify the benefits of creating walkable and bikeable environments.
CO2	Design pedestrian and bicycle facilities.
CO3	Establish processes to create, implement, and evaluate bicycle and pedestrian plans.
CO4	Assess bicycle and pedestrian safety.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	1	-	2	2	-	-	-	-	1	-	-	1	-
CO2	3	2	3	2	2	-	1	-	-	-	-	1	-	-	3	-
CO3	3	1	1	-	1	-	1	-	-	-	-	1	-	-	2	1
CO4	3	1	2	2	2	2	2	-	-	-	-	1	-	-	1	2

Detailed syllabus

1. **NMT Transport introduction:** Planning Process; measuring current non-motorized travel; predicting potential non-motorized travel; evaluating existing conditions and prioritize improvements.
2. **Evaluation of Non-motorized Transportation:** surveys, demand estimation and analysis; crash data, barrier effect; cycling condition evaluation techniques; pedestrian condition evaluation techniques; prioritizing improvements and selecting preferred options.
3. **Planning and design for Pedestrian facility:** types of pedestrians and characteristics; pedestrian facilities and planning; pedestrian standards and improvements; pedestrian facility design, los; pedestrian safety programs.
4. **Planning and design for bicycle facility:** types of cyclists and bikeways; integrating cycling into roadway planning; bicycle network planning; accommodating cyclists on rural roads; design of bicycle boulevards/bike paths; bicycle parking/storage facilities; roadway maintenance for cyclists.
5. **Implementation Strategies, Tools and Safety Programs:** comprehensive plans; road design, reconstruction and maintenance requirements; major projects and site plan agreements; land use connectivity, urban design exchange, rural areas, utility corridors, safety education; traffic law enforcement.
6. **Operations and Maintenance:** operations and maintenance resources/costs; signs and pavement markings; routine and remedial operations; routine maintenance.

Reading:

1. Myer Kutz, Editor, Handbook of Transportation Engineering, McGraw-Hill Publishers, 2004.
2. Rodney Tolley, Editor, Sustainable Transport: Planning for walking and cycling in urban environments; CRC Press, 2003.
3. ADB, Guidelines for Non-Motorised Transport Measures: Policy and Options, Asian Development Bank, 2008.
4. Fruin, Pedestrian Planning and Design, McGraw Hill Publication, 1987.
5. Hudson .M, The Bicycle Planning, Open Books, 1982.
6. IRC codes for Design and Layout of Cycle Tracks and Pedestrian Facilities.
7. John Forester, Bicycle Transportation: A Handbook for Cycling Transportation Engineers, MIT Press, 1994.

CE475	COMPUTATIONAL HYDRAULICS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE252 - Fluid Mechanics II.

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

CO1	Derive the governing equations of transients in pipes and channels
CO2	Apply method of characteristics and finite difference methods to solve unsteady flow problems in pipes and channels
CO3	Analyze transients in pumping and hydropower systems
CO4	Analyze dam break problem

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1	-	-	-	-	-	-	-	1	1	-	-	2
CO2	3	3	3	1	-	-	-	-	-	-	-	1	1	-	-	2
CO3	3	3	2	2	2	-	-	-	-	-	-	1	1	-	-	2
CO4	3	3	2	2	3	-	-	-	-	-	-	1	1	-	-	2

Detailed Syllabus:

1. Basic concepts of Numerical integration, Application to reservoir volume calculations.
2. Classification of PDEs, Computational Methods, Finite Difference Methods, Finite Volume Methods, Ordinary Differential Equations, Various orders of Runge-Kutta methods. Applications to non-linear reservoir routing.
3. Development of gradually varied flow functions, Application to backwater curves and drawdown curves computation. Analysis of pipe networks, Hardy Cross method, Variable pressure pipe networks.
4. Unsteady pipe flows and free surface flows, Saint Venant's Equations, Solutions by the method of characteristics, Analysis of dam break problems.
5. Positive and negative surge analysis, design and analysis of surge shocks.

Reading:

1. Abbot, M.A. and Vervey, Computational Hydraulics, Elsevier Publications, 1996.
2. Hoffman, J.D., Numerical Methods for Engineers and Scientists, CRC Press, Special Indian Edition, 2011.
3. M.H. Choudhary, Applied Hydraulic Transients, Van Nostrand Reinhold, New York, 2013.

CE476	WATER RESOURCES SYSTEMS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify the characteristics and objectives of water resources systems
CO2	Perform basic economic analysis to evaluate the economic feasibility of water resources projects
CO3	Formulate and solve deterministic optimization models for design and operation of water resources systems
CO4	Formulate and solve stochastic and fuzzy optimization problems for decision making under uncertainty

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2	3	2	-	1	-	-	-	1	1	1	-	2	-
CO2	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	-
CO3	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	2
CO4	3	3	3	3	3	-	1	-	-	-	1	1	1	-	3	2

Detailed Syllabus:

1. Introduction, Water Resources Planning, concepts of systems approach in planning, objectives of water resources development, Characteristics of water resources systems.
2. Economic analysis, discounting techniques, benefit cost evaluation.
3. Optimal water allocation for water supply, irrigation, and hydropower.
4. Determination of capacity of a reservoir capacity for conservation, sequent peak method, linear programming model, determination of reservoir capacity for flood control.
5. Optimal operation of a reservoir, deterministic dynamic programming, and chance constrained linear programming model and stochastic dynamic programming model.
6. Planning of an irrigation system, optimal cropping pattern, Irrigation scheduling.
7. Water quality management in a river basin and groundwater basin.

Reading:

1. Charles S. Revelle, E. Earl Whitlatch and Jeff R. Wright, Civil and Environmental Systems Engineering, Pearson Education Inc., New Jersey, 2004.
2. Loucks, D.P. and Eelco van Beek, Water Resources Systems Planning and Management – An introduction to methods, models and applications, Studies and Reports in Hydrology, UNESCO Publishing, 2005.
3. Vedula. S., and Mujumdar, P.P, Water Resources Systems-Modelling Techniques and Analysis, 2005.

CE477	HYDRO POWER ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE252 - Fluid Mechanics - II.

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

CO1	Estimate hydropower potential
CO2	Identify types of hydropower plants
CO3	Design penstocks and surge shaft
CO4	Plan the layout of a hydropower plant

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	2	3	1	2	-	-	-	-	1	2	-	3	2
CO2	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	-
CO3	3	3	3	2	3	1	1	-	-	-	-	1	1	-	3	2
CO4	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3

Detailed Syllabus:

1. Stream flow analysis, Hydrograph, Mass curve, Runoff estimation methods, estimation of hydropower potential, flow duration curves, power duration curves, pondage and storage.
2. Electrical load on hydro turbines, load curves, load duration curves, Performance factors.
3. Types of hydropower plants, Storage power plant, Runoff River plant, Pumped storage plant, two units and three unit arrangements, Reversible pump turbines, types of turbines, hydraulics of turbines, cavitation in turbine, efficiency of pumped storage plants.
4. Intakes, losses in intakes, air entrainment at intake, inlet aeration, Water conveyance systems, fore bay, canals, Tunnels and Penstocks, classification of penstocks, design criteria of penstock, economical diameter of penstock, Anchor blocks, Conduit valves, types of valves, bends and manifolds.
5. Water hammer, resonance in penstocks, channel surges, Gates, Surge tanks, Power house layout, lighting and ventilation, variations in design of power house, underground power house, structural design of power house.

Reading:

1. Arora, K.R., Irrigation Water Power and Water Resources Engineering, Standard Book Company, Delhi, 2002
2. Dandekar, M.M., and Sharma, K.N., Water Power Engineering, Vikas Publishing Company, New Delhi, 2003
3. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2009
4. Jog, M.G., Hydroelectric and Pumped Storage Plants, Wiley Eastern Ltd., New York, 1989.

CE478	WATERSHED MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CE303 - Engineering Hydrology**.**

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

CO1	Identify the causes of soil erosion
CO2	Plan and design soil conservation measures in a watershed
CO3	Plan and design water harvesting and groundwater recharging structures
CO4	Plan measures for reclamation of saline soils

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO2	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO3	3	2	3	1	1	1	2	-	-	-	-	1	2	-	3	2
CO4	3	2	3	1	1	1	2	-	-	-	-	1	1	-	3	2

Detailed Syllabus:

1. Introduction, concept of watershed, need for watershed management, concept of sustainable development, Hydrology of small watersheds.
2. Principles of soil erosion, causes of soil erosion, types of soil erosion, estimation of soil erosion from small watersheds, Control of soil erosion, methods of soil conservation – structural and non-structural measures.
3. Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures.
4. Artificial recharge of groundwater in small watersheds, methods of artificial recharge.
5. Reclamation of saline soils, Micro farming, biomass management on the farm.

Reading:

1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008.
2. Murthy, V.V.N., Land and Water Management, Khalyani Publishers, 2004.
3. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998.
4. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 1998.

OPEN ELECTIVES

(Offered to Other Department Students)

CE390	**ENVIRONMENTAL IMPACT ANALYSIS**	**PCC**	**3-0-0**	**3 Credits**

Pre-requisites: None

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

CO1	Identify the environmental attributes to be considered for the EIA study
CO2	Formulate objectives of the EIA studies
CO3	Identify the methodology to prepare rapid EIA
CO4	Prepare EIA reports and environmental management plans

Mapping of course outcomes with POs & PSOs

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	2	2	2	2	1	2	2	-	-				
CO2	1	2	2	1	2	2	2	2	2	1	-	-				
CO3	1	2	2	1	2	1	2	2	1	-	-	1				
CO4	1	2	2	2	3	2	3	1	3	1	2	1				

Detailed Syllabus:

1. Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.
2. Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.
3. EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

4. Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.
5. Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.
6. Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

CE440	BUILDING TECHNOLOGY	OPC	3-0-0	3 Credits

(This course is not offered to civil engineering students)

Pre-requisites: None

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

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans
CO2	Identify different materials, quality and methods of fabrication & construction
CO3	Adopt standard building provisions for natural ventilation and lighting
CO4	Identify effective measures for fire proofing, damp proofing, and thermal insulation

Mapping of course outcomes with POs & PSOs

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	2	2	-	-	3	-	-				
CO2	3	-	2	-	-	-	2	-	-	3	-	-				
CO3	3	-	2	-	-	-	2	-	-	-	-	-				
CO4	3	-	2	-	-	-	2	-	-	-	-	-				

Detailed Syllabus:

1. Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance. Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building
2. Termite proofing: Inspection, control measures and precautions, Lightning protection of buildings: General principles of design of openings, various types of fire protection measures to be considered while planning a building.
3. General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.
4. Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication. Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.
5. Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.
6. Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.
7. Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

OPEN ELECTIVES

(Offered to Civil Department Students)

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	-	-	1	-	-	-	-	-	-				
CO2	3	3	2	-	-	1	-	-	-	-	-	-				
CO3	3	3	2	-	-	1	-	-	-	-	-	-				
CO4	3	3	2	-	-	1	-	-	-	-	-	-				

Detailed syllabus:

1. **Introduction**: Control system, types, feedback and its effects-linearization
2. **Mathematical Modeling of Physical Systems**: Block diagram Concept and use of Transfer function. Signal Flow Graphs, Mason's gain formula.
3. **Time Domain Analysis of Control Systems** - BIBO stability, absolute stability, Routh-Hurwitz Criterion. P, PI and PID controllers. Root Locus Techniques - Root loci theory, application to system stability studies. Introduction to state variables technique, Analysis of R-L, R-L-C networks. Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co.2008.

EE391	SOFT COMPUTING TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	2	2											
CO2	3	3	1	2	2											
CO3	3	3	1	2	2											
CO4	3	3	1	2	2											

Detailed syllabus:

1. **Fundamentals Of Soft Computing Techniques**: Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.
2. **Genetic Algorithm And Particle Swarm Optimization**: Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.
3. **Ant Colony Optimization And Artificial Bee Colony Algorithms**: Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.
4. **Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm**: Bat Algorithm-Echolocation of bats- Behavior of microbats - Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes - memeplex formation- memeplex updation.

Application to multi-modal function optimization. Introduction to Multi- Objective optimization; Concept of Pareto optimality.

Reading:

1. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb “Multi-Objective Optimization using Evolutionary Algorithms”, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, “Swarm Intelligence”, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, “Swarm Intelligence-From natural to Artificial Systems”, Oxford university Press, 1999.
5. David Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, “Particle Swarm Optimization and Intelligence: Advances and Applications”, Information science reference, IGI Global, 2010.
7. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005.

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical and electronics systems.

Course Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	-	-	-	1	2	-	-	-	-	-				
CO2	1	1	-	-	-	1	2	-	-	-	-	-				
CO3	1	1	-	-	-	1	2	-	-	-	-	-				
CO4	1	1	-	-	-	1	2	-	-	-	-	-				
CO5	1	1	-	-	-	1	2	-	-	-	-	-				
CO6	1	1	-	-	-	1	2	-	-	-	-	-				

Detailed syllabus

1. Introduction: Layout of an automotive chassis, engine classification.
2. Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.
3. Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system
4. Ignition System: Battery, Magneto and Electronic, Engine Starting drives
5. Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.
6. Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods
7. Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.
8. Transmission: Clutch**-** Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.
9. Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.
10. Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M. Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H. Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME441	ROBUST DESIGN	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3		2									2				
CO2	3			3		2	2					2				
CO3	3	3		2								2				
CO4	3	3	3	3	3							2				
CO5	3	2				2	2					2				

Detailed syllabus:

1. **Introduction**: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.
2. **Design of Experiments:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.
3. **Parameter Design:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.
4. **Tolerance Design**: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

ME391	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Course Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	3	1	3	2	2	3	-				
CO2	-	-	-	-	-	3	1	3	2	2	3	-				
CO3	-	-	-	-	-	3	1	3	2	2	3	-				
CO4	-	-	-	-	-	3	1	3	2	2	3	-				
CO5	-	-	-	-	-	3	1	3	2	2	3	-				
CO6	-	-	-	-	-	3	1	3	2	2	3	-				

Detailed syllabus

1. Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.
2. Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.
3. Planning a Small Scale Enterprises**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.
4. Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.
5. Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E. Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rdEdition, Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	2	2											
CO2	3	3	1	2	2											
CO3	3	3	1	2	2											
CO4	3	3	1	2	2											

Detailed syllabus:

1. **Signal Analysis:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.
2. **Noise Analysis**: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.
3. **Amplitude (Linear) Modulation**: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier

Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

4. **Angle (Exponential) Modulation**: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.
5. **Pulse Modulation**: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.
6. **Information Theory**: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S.Haykin, Communication Systems, 4thEdn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rdEdition, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, 6thEdition, Pearson Education Inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4thEdition, MGH, New York, 2002

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	1		2											
CO2	1	1	1		2											
CO3	1	1	1		2											
CO4	1	1	1		2											

Detailed syllabus:

1. **Microcomputer Organization**: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows
2. **80386 Micro Processors**: Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387
3. **Pentium & Pentium-pro Microprocessor**: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors
4. **Microcontrollers**: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.
5. ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI, ARM9TDMI.
6. **Case study:** Industry Application of Microcontrollers

Reading:

1. Barry B. Brey: Intel Microprocessor Architecture, Programming and Interfacing-8086/8088, 80186, 80286, 80386 and 80486, PHI, 1995.
2. Muhammad Ali Mazidi and Mazidi: The 8051 Microcontrollers and Embedded systems,PHI,2008
3. Intel and ARM Data Books on Microcontrollers.

MM364	FUNDAMENTALS OF MATERIALS PROCESSING TECHNOLOGY	OPC	3 – 0 –0	3 Credits

Pre-requisites: None

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

CO1	Describe engineering materials.
CO2	Appreciate material processing techniques.
CO3	Select material processing technique for a given material and application.
CO4	Explain surface engineering techniques and their engineering significance.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2			1	1									
CO2	3	3	2			1	1									
CO3	3	3	2			1	1									
CO4	3	3	2			1	1									

Detailed syllabus:

1. **Introduction to engineering materials**: Metals, alloys and phase diagrams, ferrous metals, non-ferrous metals, superalloys, guide to processing of metals; ceramics-structure and properties of ceramics, traditional ceramics, new ceramics, glass, some important elements related to ceramics; polymers-fundamentals of polymer science and technology, thermoplastic and thermosetting polymers, elastomers; composite materials-classification of composite materials, metal matrix, polymer matrix and ceramic matrix composites.
2. **Fundamental properties of materials**: mechanical properties-stress-strain relationships, hardness, tensile properties, effect of temperature on properties, visco-elastic behaviour of polymers, thermal properties and electrical properties of metals, polymers, ceramics and composites.
3. **Metal casting fundamentals and metal casting processes**: Overview of casting technology, melting and pouring, solidification and casting, sand casting, other expendable-mold casting processes, permanent-mold casting processes, casting quality, metals for casting.
4. Particulate processing of metals and ceramics: Powder metallurgy-characterization of engineering powders, production of metallic powders, conventional processing and sintering, alternative processing and sintering techniques, materials and products for powder metallurgy, design considerations in powder metallurgy, processing of traditional ceramics, processing of new ceramics, cermets and their processing.
5. **Fundamentals of metal forming and shaping processes** (rolling, forging, extrusion, drawing, sheet metal forming) : Overview of metal forming, friction and lubrication in metal forming; bulk deformation processes in metal forming-rolling, other deformation processes related to rolling, forging, other deformation processes related to forging, extrusion, wire and bar drawing; cutting and bending operations, sheet-metal drawing, other sheet metal forming operations, dies and presses for sheet-metal processes, sheet-metal operations not performed in presses.
6. **Fundamentals welding**: Overview of welding technology, the weld joint, physics of welding, features of a fusion-welded joint; Welding processes-arc welding, resistance welding, oxy-fuel gas welding, other fusion welding processes, solid-state welding, weld quality, weldability; brazing, soldering and adhesive bonding.
7. **Surface engineering and tribology**: Importance of surface engineering, classification of surface engineering processes, introduction to thermal, mechanical, thermo-chemical and electro-chemical surface engineering processes with their advantages, limitations and applications.

Reading:

1. Kalpakjian and Schmid, Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc, New Jersey, 2010.
3. DeGarmo, Black, and Kohser, Materials and Processes in Manufacturing, John Wiley & Sons, Inc, New York, 2011.
4. R. S. Parmar, Welding processes and Technology, Khanna Publishers, 2010.
5. H.S.Bawa, Manufacturing Technology-I, Tata McGraw Hill Publishers New Delhi, 2007.
6. SeropeKalpakjian, Manufacturing processes for Engineering Materials, Addison Wesley, 2001.

CH390	NANOTECHNOLOGY AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the properties of nanomaterials
CO2	Synthesize nanoparticles
CO3	Characterize nanomaterials.
CO4	Scale up the production of nanoparticles
CO5	Evaluate safety and health related issues of nanoparticles

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1															
CO2	2		2	3												
CO3																
CO4	2		2													
CO5						3	2									

Detailed Syllabus:

1. **Introduction to Nanotechnology**: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nanosizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.
2. **Fabrication of Nanomaterials**: Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods,

Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

3. **Kinetics at Nanoscale**: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.
4. **Carbon Nanomaterials**: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallo fullerenes, solid C_{60}, bucky onions, nanotubes, nanocones.
5. **Quantum mechanics**: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots
6. **Nanomaterials characterization**: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.
7. **Applications**: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.
8. Nanoinroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,
9. **Nanobiology**: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. KulkarniSulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak, H.F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
5. Davies, J.H., The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998.

CH391	INDUSTRIAL SAFETY MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and prevention.
CO4	Assess the risks using fault tree diagram.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						3	2	1								
CO2						3	2	1								
CO3						3	2	1								
CO4						3	2	1								

Detailed syllabus:

1. **Introduction**: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, the Nature of the Accident Process, Inherent Safety.
2. **Industrial Hygiene**: Anticipation and Identification, Hygiene Evaluation, Hygiene Control.
3. Toxic Release and Dispersion Models-Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.
4. **Fires and Explosions**: The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram
5. **Hazards Identification**: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.
6. **Risk Assessment**: Review of Probability Theory, Event Trees, Fault Trees.
7. **Safety Procedures**: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures-Operating, Procedures-Permits, Procedures-Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Elsevier India, Volume 6, 2006.

CH392	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze the effects of pollutants on the environment.
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste
CO5	Select treatment methodologies for hazardous and E-waste

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						3	2									
CO2						3	2									
CO3						3	2									
CO4						3	2									
CO5						3	2									

Detailed Syllabus:

1. **Introduction**: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.
2. **Air pollution sources & effects**: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.
3. **Meteorological aspects of air pollutant dispersion**: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.
4. **Air pollution sampling and measurement**: Types of pollutant sampling and measurement, ambient air sampling, Stack sampling, Analysis of air pollutants.
5. **Air pollution control methods & equipment**: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment. Control of specific gaseous pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.
6. **Water pollution**: Water resources, Origin of wastewater, types of water pollutants and their effects.
7. **Waste water sampling, analysis and treatment**: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, advanced wastewater treatment, Recovery of materials from process effluents.
8. **Solid waste management**: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.
9. Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.
10. **E-waste**: Sources, environmental and social issues, management practices

Reading:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, Prentice Hall of India, 2nd Edition, 2004.
4. Rao M.N., Rao H.V.N, Air Pollution, Tata McGraw Hill Publishing Ltd., 1993.

5. De A.K., Environmental Chemistry, Tata McGraw Hill Publishing Ltd., 1999.
6. George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & Eddy, Inc., Franklin Burton, Waste Water Engineering: Treatment and Reuse, McGraw Hill Education; 4th Edition, 2003.
7. E-waste recycling, NPCS Board of consultants and Engineers, Asia pacific business press Inc. 2015

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3			2											
CO2	3	3			2											
CO3	3	3			2											
CO4	3	3			2											
CO5	3	3			2											

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling- event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, “Understanding object-oriented programming with Java”, Pearson, 2000.
2. Herbert Schildt, “The complete reference Java 2”, TMH, 2017.

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: CY101 **-** Chemistry

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

CO1	Address smart energy, green infrastructure and non-renewable energy challenges
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand history, global, environmental & economic impacts of green technology
CO4	Explore the usage of microorganism for the bioremediation
CO5	Synthesis the nanoparticles by various biological methods
CO6	Apply the green techniques for the production of renewable fuels

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2		1	2										
CO2	3	2	2		1	2										
CO3	3	2	2		1	2										
CO4	3	2	2		1	2										
CO5	1			1		2										
CO6		2		2			3									

Detailed Syllabus:

1. Green Technology definition, factors affecting green technologies, co/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity-WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies); design for sustainability reuse, recovery, recycle, raw material substitution, cleaner production, ISO 14000, wealth from waste, case studies.
2. Clean Technology: Biotechnology and Microbiology of Degradation of coal – Aerobic and Anaerobic pathway of coal degradation, Biogas technology, Microbial and biochemical aspects, Operating parameters for biogas production, kinetics and mechanism - Dry and wet fermentation. Digesters for rural application - High rate digesters for industrial waste water treatment.
3. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in Indian context; tidal and geothermal energy, Design and operation of Fixed and Fluidized Bed Gasifiers. Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings.

Future utilization of biomass in India. Future of landscape management: optimal management.

4. Nano particles preparation techniques, Greener Nano synthesis: Greener Synthetic Methods for Functionalized Metal Nan particles, Greener Preparations of Semiconductor and Inorganic Oxide Nano particles, green synthesis of Metal nanoparticles, Nanoparticle characterization methods, Green materials: biomaterials, biopolymers, bioplastics, and composites. Nanomaterials for Fuel Cells and Hydrogen; Generation and storage, Nano-structures for efficient solar hydrogen production, Metal Nanoclusters in Hydrogen Storage Applications, Metal Nanoparticles as Electro-catalysts in Fuel Cells, Nanowires as Hydrogen Sensors.

Reading:

1. Ristinen, Robert Kraushaar, Jack J.A Kraushaar, Jack P. Ristinen, Robert A.,Energy and the Environment, 2nd Edition, John Wiley, 2006.
2. B. R Wilson & W J Jones, Energy, Ecology and the Environment, Academic PressInc, 2005.
3. Sarkar S, Fuels and combustion, 2nd ed., University Press, 2009.

SM390	MARKETING MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2							2	1	2					
CO2	2	2							2	1	2					
CO3	2	2							2	1	2					
CO4	2	2							2	1	2					

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.
Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.
Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.
Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior- Psychological factors, social factors, cultural factors and personal factors.
Importance of Market segmentation, Target market selection and positioning.
Importance of new product development process and the various stages involved.
The concept of product lifecycle and the various strategies used by the marketer in each stage.
Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.
Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.
Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.
Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton & Etzel, Marketing Management,TMH, 13thEdition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1	1							2				
CO2	3	3	1	1	1							2				
CO3	3	3	1	1	1							2				
CO4	3	3	1	1	1							2				
CO5	3	3	1	1	1							2				

Detailed Syllabus:

1. **Ordinary Differential Equations**: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods
2. **Finite difference methods**: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.
3. **Partial Differential Equations**: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.
4. **Hyperbolic Equations**: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.
5. **Elliptic equations**: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	FUZZY MATHEMATICS AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1	2	1										
CO2	3	3	1	1	2	1										
CO3	3	3	1	1	2	1										
CO4	3	3	1	1	2	1										
CO5	3	3	1	1	2	1										

Detailed Syllabus:

1. **Crisp set theory (CST):** Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.
2. **Fuzzy set theory (FST):** Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.
3. Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.
4. **Predicate Logic (PL2):** Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution
5. **Fuzzy Relations (FR):** [redacted]-cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.
6. **Fuzzy Logic (FL):** Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL. **Switching functions (SF) and Switching circuits (SC):** Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.
7. **Applications:** Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2		1	2										
CO2	3	2	2		1	2										
CO3	3	2	2		1	2										
CO4	3	2	2		1	2										
CO5	3	2	2		1	2										
CO6	3	2	2		1	2										

Detailed Syllabus:

1. **General Introduction:** The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.
2. **Origin of Bio potentials**: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.
3. **The Electroneurogram (ENG):** The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.
4. **Blood Pressure:** indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic noninvasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

5. **Blood flow and Volume Measurement:** indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.
6. **Pulse Oximeter:** Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.
7. **Cardiac Pacemakers**: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design, John Wiley, 3rd Edition, 2012.
2. Joseph J. Carr & John M. Brown, Introduction to biomedical Equipment Technology, 4th Edition, Prentice Hall India, 2001

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3			1										
CO2	3	3	3			1										
CO3	3	3	3			1										
CO4	3	3	3			1										
CO5	3	3	3			1										

Detailed Syllabus:

1. **Nano Materials**: Origin of nanotechnology, Classification of nanomaterials, Physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel,

electro deposition, ball milling, carbon-nano tubes(CNT).Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanowires, nanobiology, nanomedicines.

2. **Biomaterials:** Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopedicimplants, dental materials.
3. **Composites:** General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.
4. **Optical materials:** Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.
5. **Super conducting materials:** Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.
6. **Smart materials:** An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.
7. **Surface Acoustic Wave (SAW) Materials and Electrets:** Delay lines, frequency filters, resonators, pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Reading:

1. T. Pradeep, Nano: The Essentials; TATA McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 2012.
3. Krishan K Chawla, Composite Materials; 2ndEdition, Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the concepts of ultraviolet and visible absorption and fluorescence techniques for material characterization.
CO2	Understand the various liquid, gas and size-exclusion chromatographic techniques the automated continuous analysis of environmental, industrial, production-line materials
CO3	Understand the concepts of various electro analytical techniques for characterization of interfaces and traces of surface adsorbed-materials.
CO4	Understands the principles of thermogravimetry and differential thermal analyses (TGA and DTA) for applications into pharmaceuticals, drugs, polymers, minerals, toxins and in Finger Print Analysis
CO5	Identification of suitable analytical technique for characterization of chemical, inorganic and engineering materials

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3		3	1	1	1									
CO2	3	3		3	1	1	1									
CO3	3	3		3	1	1	1									
CO4	3	3		3	1	1	1									
CO5	3	3		3	1	1	1									

Detailed Syllabus:

1. **UV-Visible Spectrophotometry and Fluorescence**: Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.
2. **Atomic spectrometry, atomic absorption, X-ray fluorescence methods**: Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, instrumentation, quantitative analysis.
3. **Chromatography methods:** Gas chromatography, High performance liquid chromatography, size exclusion chromatography, Principle, Basic instrumentation, terminology, NPC, RPC, Qualitative and Quantitative applications. Capillary Electrophoresis: Principle and application.
4. **Thermo analytical methods**: Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations

5. **Electro analytical methods:** Coulometric methods, Polarography, Pulse voltametric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric Sensors, Applications.
6. **Spectroscopic methods**: Molecular absorption, Woodward rules, applications, Infrared absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications
7. Mass spectrometry: Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Gurdeep Chatwal and Sham Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, 1986.
2. Skoog, Holler and Kouch, Instrumental methods of analysis, Thomson, 2007.
3. Mendham, Denny, Barnes and Thomas, Vogel: Text book of quantitative chemical analysis, Pearson, 6Edotion, 2007.
4. William Kemp, Organic spectroscopy, McMillan Education, UK, 1991.
5. Instrumental methods of analysis – Willard, Meritt and Dean, PHI, 2005.

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Course Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1								3	1	3	2					
CO2								3	1	3	2					
CO3								3	1	3	2					
CO4								3	1	3	2					
CO5								3	1	3	2					

Detailed Syllabus:

1. **English Language Enhancement:** Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English.
2. Art of Communication, Communication process- Non-verbal Communication- Effective Listening.
3. **Interpersonal and Intra Personal Communication Skills**: Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles- Leadership.
4. Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.
5. **Interview Handling skills**: Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody 4th Edition, Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009.

EE440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

Pre-requisites: None

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

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						3	1	3	2	2	3					
CO2						3	1	3	2	2	3					
CO3						3	1	3	2	2	3					
CO4						3	1	3	2	2	3					

Detailed syllabus:

1. **Entrepreneur and entrepreneurship:** Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE.
2. **Establishing the Small Scale Enterprise**: Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.
3. **Operating the Small Scale Enterprises**: Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE.

Reading:

1. Holt, Entrepreneurship: New Venture Creation, PHI (P), Ltd., 2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C.Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
5. J.B.Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S SModi, A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Course Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	-	2	-	-	3	3	-	-	-	-	-				
CO2	2	-	2	-	-	3	3	-	-	-	-	-				
CO3	2	-	2	-	-	3	3	-	-	-	-	-				
CO4	2	-	2	-	-	3	3	-	-	-	-	-				
CO5	2	-	2	-	-	3	3	-	-	-	-	-				
CO6	2	-	2	-	-	3	3	-	-	-	-	-				

Detailed Syllabus:

1. Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies
2. Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods
3. Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data
4. Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems
5. Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.
6. Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems
7. Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics
8. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.
9. Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K. Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.

EE441	PRINCIPLES OF ELECTRIC POWER CONVERSION	OPC	3–0– 0	3 Credits

Pre-requisites: None

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

CO1	Understand the basics in the electric power conversion using power switching devices
CO2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO3	Analyze the different energy storage systems
CO4	Identify the various Industrial and domestic applications

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	1	1	1	1	1									
CO2	1	2	1	1	1	1	1									
CO3	1	2	1	1	1	1	1									
CO4	1	2	1	1	1	1	1									

Detailed syllabus:

1. **Power Electronic Devices and Converters**: V-I characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.
2. **Applications to Electric Drives**: Speed control of DC motor, Induction motors, PMSM and BLDC drives
3. **Applications to Renewable Energy**: Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.
4. **Energy Storage Systems**: Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.
5. **Domestic And Industrial Applications**: Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Reading:

1. M.H. Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, New Delhi, 2009.
2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi, 2012.
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons,Inc.NewYork, 2006.

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1		1	1	1									
CO2	2	2	1		1	1	1									
CO3	2	2	1		1	1	1									
CO4	2	2	1		1	1	1									

Detailed syllabus:

1. **Measurement And Error**: Sensitivity, Resolution, Accuracy and precision, absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.
2. **Instruments**: D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.
3. **Impedance Measurement**: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.
4. **Oscilloscopes**: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.
5. **Special instruments**: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.
6. **Transducers** *(Qualitative Treatment Only):* Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.
7. **Introduction to Data Acquisition Systems (DAS)**: Block Diagram, Specifications and various components of DAS.
8. **General purpose Instrumentation Bus (GP-IB):** Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford, 2013.

MM499	METALLURGY FOR NON-METALLURGISTS	OPC	3-0-0	3 Credits

Pre-requisites: None

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

CO1	Discuss the characteristics and applications of metals and alloys.
CO2	Explain different fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1		1	1	1									
CO2	2	2	1		1	1	1									
CO3	2	2	1		1	1	1									
CO4	2	2	1		1	1	1									

Detailed syllabus:

1. **Introduction to Metallurgy:** Metals and Alloys classification, engineering applications of metals/alloys.
2. **Structure of Metals and Alloys**: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals.
3. **Mechanical Properties**: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture
4. Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening
5. **Fabrication and Finishing of metal products:** Metal Working and Machining
6. **Testing of Metals**: Destructive and Non-Destructive Testing, Inspection and Quality Control of Metals.
7. **Engineering Alloys**: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, selective non-ferrous metals and alloys.
8. **Heat Treatment**: Annealing, Normalizing, Hardening and Tempering.
9. **Material selection processes**: Case studies

Reading:

1. M. F. Ashby, Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. R. Abbaschian, L. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, East-West Press, 2009.
4. V Raghavan, Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI Publications, 2011

CH440	DATA DRIVEN MODELLING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify disturbance models
CO2	Estimate parametric and non-parametric models
CO3	Determine the model structure
CO4	Validate the developed models

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	2	2							1				
CO2	2	2	1	2	2							1				
CO3	2	2	1	2	2							1				
CO4	2	2	1	2	2							1				

Detailed syllabus:

1. System Identification - Motivation and Overview. Models of Discrete-Time LTI Systems – Convolution equation. Difference equations, Transfer functions, State-space models, Discretization, Sampling and Hold operations, sampling theorem.
2. Disturbance models - random processes, representation of stationary processes, white-noise process, auto-covariance function (ACF), ARMA models. Parametric model structures - ARX, ARMAX, OE, BJ and PEM – structures and their applicability in real-time.
3. Linear Regression - Least Squares estimates, Statistical properties of LS Estimates. Weighted Least Squares, Recursive Least Squares, Maximum Likelihood Estimation and properties.
4. Estimation of non-parametric models - impulse / step response coefficients, frequency response models.
5. Estimation of parametric models - notions of prediction and simulation, predictors for parametric models, prediction-error methods, Instrumental Variable method.

6. Model Structure Selection and Diagnostics -estimation of delay and order, residual checks, properties of parameter estimates, model comparison and selection, model validation.

Reading:

1. Arun K. Tangirala. System Identification: Theory and Practice, CRC Press, 2014.
2. Karel J. Keesman, System Identification – An Introduction, Springer, 2011.
3. Nelles, O. Nonlinear System Identification, Springer-Verlag, Berlin, 2001.
4. Zhu, Y. Multivariable System Identification for Process Control, Pergamon, 2001.
5. Ljung, L. System Identification: Theory for the User, Prentice-Hall, 2nd Edition, 1999.
6. J. R. Raol, G. Girija, J. Singh, Modeling and Parameter Estimation of Dynamic Systems, The Institution of Electrical Engineers, 2004.
7. Rolf Johansson, System Modeling and Identification, Prentice Hall, 1993.

CH441	FUEL CELL TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Demonstrate the operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2														
CO2	2	2		2												
CO3	2	2		3												
CO4	2	2														

Detailed syllabus:

1. **Overview of Fuel Cells**: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.
2. Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.
3. **Fuel cell electrochemistry**: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.
4. **Fuel cell process design**: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

5. Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling
6. **Fuel processing**: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Hoogers G, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, 2006.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2nd Edition, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications
5. Laminie J, Dicks A, Fuel Cell Systems Explained, 2nd Edition, John Wiley, New York, 2003.

CH442	DESIGN OF EXPERIMENTS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Design experiments for a critical comparison of outputs
CO2	Propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1				3	2							2				
CO2	3	3		3								2				
CO3	3			3	2							2				
CO4				3	2							2				

Detailed syllabus:

1. **Introduction**: Strategy of experimentation, basic principles, guidelines for designing experiments.
2. **Simple Comparative Experiments**: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.
3. **Experiments with Single Factor**: An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression

approach to the analysis of variance, Nonparametric methods in the analysis of variance, Problems.

4. **Design of Experiments**: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments, Parameter Estimation.
5. **Response Surface Methods**: Introduction, The methods of steepest ascent, Analysis of a second-order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems.
6. **Design and Analysis**: Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment-method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.

Reading:

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2005.
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heinemann, 2004.
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5thEdition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-Hill, 1995.

CH443	CARBON CAPTURE, SEQUESTRATION AND UTILIZATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2 capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						2	2									
CO2						2	2									
CO3						2	2									
CO4						2	2	2								

Detailed syllabus:

1. **Introduction**: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprint, carbon capture, storage and utilization (CCS&U)
2. **CO_2 capture technologies from power plants**: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion
3. **CO_2 capture agents and processes**: Capture processes, CO_2 capture agents, adsorption, ionic liquids, metal organic frameworks
4. **CO_2 storage and sequestration**: Geological sequestration methods, Biomimetic carbon sequestration
5. **CO_2 Utilization**: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO_2 to oxygenated organics, Conversion into higher carbon fuels, High temperature catalysis
6. **Environmental assessment of CO_2 capture and utilization**: Need for assessment, Green chemistry and environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO_2 capture and Utilization.

Reading:

1. Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Carbon dioxide utilization: Closing the Carbon Cycle, Elsevier, 2015.
2. Goel M, Sudhakar M, Shahi RV, Carbon Caputre, Storage and Utilization: A Possible climate change solution for energy industry, TERI, Energy and Reosurces Insitute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO_2 Management Technologies, CRC Press, 1st Edition, 2014.
4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO_2) Capture, Woodhead Publishing Series in Energy: No. 82, 2015.
5. Mercedes Maroto-Valer M, Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Vol 2, Woodhead Publishing Series in Energy, 1st Edition, 2014.

CS440	MANAGEMENT INFORMATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			1		3			2			2					
CO2			1		3			2			2					
CO3			1		3			2			2					
CO4			1		3			3			2					
CO5			1		3			2			3					

Detailed syllabus:

Organization and Information Systems, Foundation Concepts, Information Systems in Business, Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology.

Reading:

1. Kenneth J Laudon, Jane P. Laudon, Management Information Systems, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, Management Information Systems, 3rd Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand bio-sensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bio-analytical devices and design of biosensors

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	2		1	2										
CO2	3	2	2		1	2										
CO3	3	2	2		1	2										
CO4	3	2	2		1	2										

Detailed Syllabus:

1. **General principles:** A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.
2. **Physico-chemical transducers:** Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transducers.
3. **Biorecognition systems and Biosensor Engineering:** Enzymes; Oligonucleotides and Nucleic Acids; Membrane receptors, Cells; Immunoreceptors; Limitations & problems. Immobilization of biomolecules, Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS.

4. **Application of modern sensor technologies:** Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations..

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, 1st Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2							2	1	2					
CO2	2	2							2	1	2					
CO3	2	2							2	1	2					

Detailed Syllabus:

1. **Introduction to Human Resource Management**: Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.
2. **Human Resource Planning**: Demand Forecasting Techniques, Supply Forecasting Techniques, Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.
3. **Human Resource Development**: Orientation, Training and Development, Management, Development, Performance Appraisal and Employee Compensation, Factors Influencing, Employee Remuneration and Challenges of Remuneration. Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH, 2010.
2. Garry Dessler and Biju Varkkey, Human Resource Management, PEA, 2011.

3. Noe & Raymond, HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1	2											
CO2	3	3	1	1	2											
CO3	3	3	1	1	2											
CO4	3	3	1	1	2											

Detailed Syllabus:

1. **Linear Programming**: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .
2. **Nonlinear Programming**: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.
3. **Dynamic Programming**: Principle of optimality, recursive relations, solution of LPP.
4. Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. KantiSwarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand& Co., 2006
2. J.C.Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo,Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1	2											
CO2	3	3	1	1	2											
CO3	3	3	1	1	2											
CO4	3	3	1	1	2											

Detailed Syllabus:

1. **Linear Programming**: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.
2. **Transportation Problems**: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degeneracy in Transportation problems. Queuing Theory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1): (∞/FIFO) and its characteristics.
3. **Elements of Inventory Control**: Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. K. Swarup, Manmohan & P.K. Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	1	1												
CO2	3	1	1	1												
CO3	3	1	1	1												
CO4	3	1	1	1												

Detailed Syllabus:

1. **General properties of Nano materials**: Origin of nanotechnology. Classification of nanomaterials. Fullerene, carbon nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.
2. **Fullerenes and Carbon Nanotubes (CNT's)**: Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase, Transport, mechanical, physical properties of CNT's.
3. **Investigation and manipulating materials in the Nanoscale**: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.
4. SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.
5. **Semi conducting Quantum Dots**: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.
6. **Nanobiology**: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.
7. **Nanosensors**: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.
8. **Nanomedicines**: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T.Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R.Fahrner,Nanotechnology and Nanoelectronics;Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	1		1	2	1								
CO2	3	3	1	1		1	2	1								
CO3	3	3	1	1		1	2	1								
CO4	3	3	1	1		1	2	1								

Detailed Syllabus:

1. **Overview of biomaterials**: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.
2. **Structure and properties of biomaterials**: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.
3. **Types of biomaterials**: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.
4. **Characterization of materials**: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.
5. **Bio implantation materials**: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.
6. **Tissue response to implants**: Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes, Biomaterials an introduction; 3rd Edition, Springer, 2007
2. Sujatha V Bhat, Biomaterials; 2nd Edition, Narosa Publishing House, 2006.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Demonstrate a systematic knowledge of the range and breadth of application of nanomaterials.
CO2	Review critically the potential impact, in all classes of materials, of the control of nanostructure
CO3	Describe the methods for the synthesis and nanostructural characterization of such materials.
CO4	Identify the possible opportunities for nanomaterials in society development and enhancement.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	1	1		2	2									
CO2	3	1	1	1		2	2									
CO3	3	1	1	1		2	2									
CO4	3	1	1	1		2	2									

Detailed Syllabus:

1. **Introduction**: Review the scope of nanoscience and nanotecnology, understand the nanoscience in nature, classification of nanostructured materials and importance of nano materials.
2. **Synthetic Methods**: Teach the basic principles for the synthesis of Nanostructure materials by Chemical Routes (Bottom-Up approach):-Sol-gel synthesis, microemulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis and Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.
3. **Techniques for characterization**: Learning of characterization method by various techniques like, Diffraction Technique:-Powder X-ray diffraction for particle size analysis, Spectroscopy Techniques:-Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement, Electron Microscopy Techniques:-Scanning electron microscopy (SEM)and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM)BET method for surface area determination and Dynamic light scattering technique for particle size analysis.
4. **Studies of nano-structured Materials**: Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, core-shell nanoparticles,

nanoshells, self- assembled monolayers, and monolayer protected metal nanoparticles, nanocrystalline materials.

Reading:

1. T Pradeep, NANO: The Essentials, McGraw-Hill, 2007.
2. B S Murty, P Shankar, Baldev Rai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology, Univ. Press, 2012.
3. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications, Imperial College Press, 2007.
4. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Narosa Pub., 2010.
5. Manasi Karkare, Nanotechnology: Fundamentals and Applications, IK International, 2008.
6. C. N. R. Rao, Achim Muller, K. Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007.

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1								3	1	3	2					
CO2								3	1	3	2					
CO3								3	1	3	2					
CO4								3	1	3	2					
CO5								3	1	3	2					
CO6								3	1	3	2					

Detailed Syllabus:

1. **Importance of Corporate communication**: Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

2. **Oral Communication**: Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.
3. **Written Communication**: Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.
4. **Corporate responsibility**: Circulating to employees vision and mission statements- ethical practices- Human rights - Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.
5. **Corporate Ethics and Business Etiquette**: Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.
6. **Listening Skills**: Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.
7. **Leadership Communication Styles**: Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohan and Meera Banerji, Developing Communication Skills: Macmillan Publishers India,2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill,2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999