NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH



SCHEME OF INSTRUCTION AND SYLLABI

B.Tech. – Civil Engineering

Effective from 2020-21

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

To nurture and produce highly competent engineers, scientists and entrepreneurs committed towards catering to futuristic societal challenges through holistic education synergetic with innovations and vibrant research eco-system.

MISSION

- To implement best practices in teaching-learning methodologies for establishing dynamic knowledge-connected society.
- To create a conducive environment for carrying out research in multi-disciplinary areas and thereby nurturing novel thinking capabilities.
- To strengthen industry-institute interface to inculcate entrepreneurship abilities.
- To address all technological needs of the Nation for self-sustenance.

DEPARTMENT OF CIVIL ENGINEERING

VISION

To lead the global community by producing outstanding Civil Engineers through quality technical education, research and build the legacy of entrepreneurship who can serve for industry and society through their innovative thinking.

MISSION

- To design a curriculum which caters the present and future challenges and establish a Centre of Excellency in Civil Engineering.
- To carry out novel research, on problems prevalent in society and provide sustainable solutions in various disciplines of Civil Engineering.
- To have industry connect for combating the multi-dimensional problems through collaborations.
- To promote innovative ideas among the students to excel as a future entrepreneur.

DEPARTMENT OF CIVIL ENGINEERING:

About the Department:

The Civil Engineering Department offers B.Tech., M.Tech. (Geotechnical Engineering), M.S. (by Research) and Ph.D. Programmes. The department was incepted in the year 2015 with a sanctioned intake of 60 students and later in the year 2021, the strength was increased to 100 for the B.Tech. (Civil) programme, M.Tech., (2021) and Ph.D. Programmes (2019). The Department is actively involved in basic and applied research in the field of Structural Engineering, Geotechnical Engineering, Water Resources Engineering and Environmental Engineering. Broad area of the current research focus of the Department includes Earthquake Engineering, Environmental Geotechnology, Structural Health Monitoring, Wastewater Treatment, GIS-based Hydrological Modelling, and Integrated Watershed Management.

List of Programs offered by the Department:

Program	Title of the Program
B.Tech.	Civil Engineering
MTech.	Civil Engineering (Specialisation in Geotechnical Engineering)
MS (by Research)	Civil Engineering
Ph.D.	Civil Engineering

Note: Refer to the Rules and Regulations for B.Tech. program (weblink) given on the institute website.

B.Tech. – Civil ENGINEERING

Program Outcomes (POs)

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

PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and chemical engineering to the solution of complex engineering problems.
PO 2	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design solutions for complex chemical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex chemical engineering activities with an understanding of the limitations.
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the chemical engineering practice.
PO 7	Understand the impact of the chemical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

At the end of the B.Tech. in Civil Engineering programme, graduates will be able to:

PSO1	Survey, map, measure and analyse earth surface features and natural resources
PSO2	Characterize and evaluate materials for adoptability in civil engineering projects
PSO3	Analyse and design infrastructural facilities needed for the society and apply best management practices for construction and maintenance of these facilities
PSO4	Predict, forecast and take measures for mitigation of natural and manmade hazards

Degree Requirements for B.Tech. (Civil) Programme

	Proposed Credits (New Regulation)
Basic Science Core (BSC)	**19 (11.73%)**
Engineering Science Core (ESC)	**14 (8.64%)**
Humanities and Social Science Core (HSC)	**06 (3.7%)**
Program Core Courses (PCC)	**71 (43.83%)**
Departmental Elective Courses (DEC)	**15 (9.26 %)**
Open Elective Courses (OPC)	**09 (5.56%)**
Program Major Project (PRC)/ Skill Development (SD)/Foreign Languages	**22 (13.58%)**
EAA: Games and Sports (MSC)	**2 (1.23%)**
MOOCs (MOE)	**4 (2.47%)**
Total	**162**

Choice Based Credit System: 26.54 %

NOTE: The minimum no. of credits required to award B.Tech. degree is 162

Credit Distribution in Each Semester										
	I	II	III	IV	V	VI	VII	VIII	TOT	REQ
BSC	8	8	3	0	0	0	0	0	**19**	**≥ 19**
ESC	4	10	0	0	0	0	0	0	**14**	**≥ 14**
HSC	3	0	0	0	0	3	0	0	**06**	**≥ 06**
PCC	0	0	17	20	16	8	10	0	**71**	**≥ 62**
DEC	0	0	0	0	0	6	6	3	**15**	**≥ 15**
OPC	0	0	0	0	3	3	0	3	**09**	**≥ 09**
PRC/ SD	5	2	0	2	0	3	4	6	**22**	**≥ 15**
EAA (MSC)	1	1	0	0	0	0	0	0	**2**	**≥ 2**
MOOCS (MOE)	0	0	0	0	0	2	0	2	**4**	**≥ 4**
	21	**21**	**20**	**22**	**19**	**25**	**20**	**14**	**162**	

SCHEME OF INSTRUCTION

I Year B.Tech. Course Structure (Common for all branches)

Physics Cycle							
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101/ MA151	Differential and Integral Calculus / Matrices and Differential Equations	3	0	0	**03**	**BSC**
2	HS101	English for Technical Communication	2	0	2	**03**	**HSC**
3	PH101	Engineering Physics	3	0	0	**03**	**BSC**
4	EC101	Basic Electronics Engineering	2	0	0	**02**	**ESC**
5	CE102	Environmental Science and Engineering	2	0	0	**02**	**ESC**
6	CS101	Introduction to Algorithmic Thinking and Programming	3	0	0	**03**	**SD**
7	CS102	Introduction to Algorithmic Thinking and Programming Lab	0	1	2	**02**	**SD**
8	PH102	Engineering Physics Lab	0	1	2	**02**	**BSC**
9	EA101/ EA151	Physical Education/Health Education	0	0	3	**01**	**MSC**
		TOTAL	**15**	**2**	**9**	**21**	

Chemistry Cycle							
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101/ MA151	Differential and Integral Calculus / Matrices and Differential Equations	3	0	0	**03**	**BSC**
2	ME102	Engineering Graphics with Computer Aided Drafting	0	1	2	**02**	**ESC**
3	CY101	Engineering Chemistry	3	0	0	**03**	**BSC**
4	EE101	Elements of Electrical Engineering	2	0	0	**02**	**ESC**
5	BT101	Biology for Engineers	2	0	0	**02**	**ESC**
6	ME101	Basics of Mechanical Engineering	2	0	0	**02**	**ESC**
7	CE101	Engineering Mechanics	2	0	0	**02**	**ESC**
8	ME103	Workshop Practice	0	1	2	**02**	**SD**
9	CY102	Engineering Chemistry Lab	0	1	2	**02**	**BSC**
10	EA101/ EA151	Physical Education/Health Education	0	0	3	**01**	**MSC**
		TOTAL	**14**	**3**	**9**	**21**	

Note:

BSC: Basic Science Core
HSC: Humanities and Social Science Core
DEC: Departmental Elective Courses
ESC: Engineering Science Core
PCC: Program Core Courses
OPC: Open Elective Courses

Program Major Project (PRC)/Skill Development (SD)/Foreign Languages	EAA (MSC): Games and Sports MOOCs (MOE)

SCHEME OF INSTRUCTION
II Year B.Tech. Civil Engineering Course Structure

Summer Internship – I#

Semester-III							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA203	Mathematical Methods	3	0	0	3	BSC
2	CE201	Strength of Materials - I	3	1	2	5	PCC
3	CE202	Fluid Mechanics	3	0	2	4	PCC
4	CE203	Environmental Engineering - I	3	0	0	3	PCC
5	CE204	Engineering Geology & Surveying	3	0	0	3	PCC
6	CE205	Surveying Laboratory	0	0	2	1	PCC
7	CE206	Environmental Engineering Laboratory	0	0	2	1	PCC
		TOTAL	**15**	**1**	**8**	**20**	

Semester-IV							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	CE251	Strength of Materials - II	4	0	0	4	PCC
2	CE252	Open Channel Hydraulics	3	0	0	3	PCC
3	CE253	Geotechnical Engineering - I	4	0	0	4	PCC
4	CE254	Building Materials and Concrete Technology	4	0	0	4	PCC
5	CE255	Engineering Hydrology	3	0	0	3	PCC
6	CE256	Hydraulic Engineering Laboratory	0	0	2	1	PCC
7	CE257	Concrete Technology Laboratory	0	0	2	1	PCC
8	CE299	Mini Project – I (EPICS based)	0	0	4	2	SD
		TOTAL	**18**	**0**	**8**	**22**	

Summer Internship – II#

SCHEME OF INSTRUCTION
III Year B.Tech. Civil Engineering Course Structure

Semester-V							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	CE301	Structural Analysis-I	3	0	0	3	PCC
2	CE302	Geotechnical Engineering-II	3	0	0	3	PCC
3	CE303	Design of Concrete Structures	3	1	0	4	PCC
4	CE304	Irrigation Engineering	3	1	0	4	PCC
5	CE305	Geotechnical Engineering Laboratory	0	0	2	1	PCC
6	CE306	Building Drawing	0	0	2	1	PCC
7	CE340	Open Elective – 1 / Foreign Language	3	0	0	3	OPC/SD
		TOTAL	**15**	**2**	**4**	**19**	

Semester-VI							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	CE351	Transportation Engineering-I	3	0	0	3	PCC
2	CE352	Environmental Engineering - II	4	0	0	4	PCC
3	CE353	Transportation Engineering Laboratory	0	0	2	1	PCC
4	CE361	Department Elective – 1	3	0	0	3	DEC
5	CE362	Department Elective – 2	3	0	0	3	DEC
6	CE390	Open Elective – 2 / Foreign Language	3	0	0	3	OPC /SD
7	SM355	Engineering Economics and Management	3	0	0	3	HSC
8	CE399	Mini Project – II	0	0	6	3	SD
9	MCE3XX	MOOCS-1	2	0	0	2	MOE
		TOTAL	**21**	**0**	**8**	**25**	

Summer Internship – III[#]

#: The student can do Summer Internship with duration of minimum 45 days at Institutes / Organizations / Industries and produce the certificate of completion and copy of internship report to the department.
It is optional only, Not Mandatory.

SCHEME OF INSTRUCTION
IV Year B.Tech. Civil Engineering Course Structure

Semester-VII							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	CE401	Transportation Engineering-II	3	0	0	03	PCC
2	CE402	Remote Sensing in Civil Engineering	3	0	0	03	PCC
3	CE403	Design of Steel Structures*	3	0	0	03	PCC
4	CE404	Civil Engineering Software Laboratory	0	0	2	01	PCC
5	CE 4XX	Department Elective –3	3	0	0	03	DEC
6	CE 4XX	Department Elective – 4	3	0	0	03	DEC
7	CE 449	Project-Work Part – A	0	0	8	04	PRC
		TOTAL	**15**	**0**	**10**	**20**	

*: The PCC Course may be offered with the support of Industry.

Semester-VIII							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	CE 4XX	Department Elective – 5	3	0	0	03	DEC
2	CE 490	Open Elective – 3*	3	0	0	03	OPC
3	MCE4XX	MOOCS-2	2	0	0	02	MOE
4	CE 499	Project-Work Part – B (with option of Industrial Training /Internship)	0	0	12	06	PRC
		TOTAL	**8**	**0**	**12**	**14**	

*If the students are in Industrial training, the electives may be conducted online.

Professional Elective Courses:

S. No.	Course Code	Course Name	L	T	P	C	Category Code
Department Elective – 1 (Semester-VI)							
1.	CE361	Structural Analysis-II	3	0	0	3	DEC
Department Elective – 2 (Semester-VI)							
1.	CE362	Construction Technology and Project Management	3	0	0	3	DEC
Department Elective – 3 & 4 (Semester-VII)							
1.	CE411	Prestressed Concrete	3	0	0	3	DEC
2.	CE412	Introduction to Structural Dynamics	3	0	0	3	DEC
3.	CE413	Bridge Engineering	3	0	0	3	DEC
4.	CE414	Quantity Surveying and Public Works	3	0	0	3	DEC
5.	CE415	Foundation Analysis and Design	3	0	0	3	DEC
6.	CE416	Ground Improvement Techniques	3	0	0	3	DEC
7.	CE417	Applications of Geosynthetics	3	0	0	3	DEC
8.	CE418	River Engineering	3	0	0	3	DEC
9.	CE419	Design of Hydraulic Structures	3	0	0	3	DEC
10.	CE420	Watershed Management	3	0	0	3	DEC
11.	CE421	Pavement Analysis and Design	3	0	0	3	DEC
12.	CE422	Traffic Engineering and Design	3	0	0	3	DEC
13.	CE423	Industrial Waste Treatment	3	0	0	3	DEC
14.	CE424	Air Pollution	3	0	0	3	DEC
15.	CE425	Environmental Modelling	3	0	0	3	DEC
Department Elective – 5 (Semester-VIII)							
1.	CE461	Applied Stress Analysis	3	0	0	3	DEC
2.	CE462	Repair And Rehabilitation of Structures	3	0	0	3	DEC
3.	CE463	Design of Earthquake Resistant Structures	3	0	0	3	DEC
4.	CE464	Introduction to Soil Dynamics	3	0	0	3	DEC
5.	CE465	Earthquake Geotechnical Engineering	3	0	0	3	DEC
6.	CE466	Geographical Information Systems	3	0	0	3	DEC
7.	CE467	Climatology & Climate Change	3	0	0	3	DEC
8.	CE468	Road Safety Engineering	3	0	0	3	DEC
9.	CE469	Environmental Impact Assessment	3	0	0	3	DEC
10.	CE470	Solid Waste Management	3	0	0	3	DEC
11.	CE471	Introduction to Life Cycle Analysis	3	0	0	3	DEC

Open Elective Courses (offered to other departments):

S. No.	Course Code	Course Name	L	T	P	C	Category Code
Open Elective – 1 (Semester-V)							
01	CE340	Repair and Rehabilitation of Infrastructure	3	0	0	3	OPC
Open Elective – 2 (Semester-VI)							
01	CE390	Infrastructure for Smart Cities	3	0	0	3	OPC
Open Elective – 3 (Semester-VIII)							
01	CE490	Disaster Management	3	0	0	3	OPC

Note:

1. A student is permitted to register/do either Minor or Honours only, but not both.

2. A student is permitted to register/do only one minor/ one Honours.

Minor in Geoinformatics: Course Structure							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Offered SEM**
01	CEM251	Unmanned Aerial Systems	4	0	0	4	IV
02	CEM301	Principles of Remote Sensing	4	0	0	4	V
03	CEM351	Digital Image Processing	4	0	0	4	VI
04	CEM401	Fundamentals of GIS	4	0	0	4	VII

Minor in Environmental Sustainability: Course Structure							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Offered SEM**
01	CEM261	Sustainability for Engineers	4	0	0	4	IV
02	CEM311	Basics of Life Cycle Analysis	4	0	0	4	V
03	CEM361	Environmental Impact Assessment	4	0	0	4	VI
04	CEM411	Basics of Climate Change	4	0	0	4	VII
05	CEM412	Integrated Solid Waste Management	4	0	0	4	VII

DETAILED SYLLABUS

MA101	Differential and Integral Calculus I B.Tech. I Semester - all sections	BSC	3-0-0	3 Credits

Pre-requisites: None

Differential Calculus of functions of several variable: Review of Limit, continuity (sequential verification) and differentiability, 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. (14)

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. (14)

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; Stokes' theorem; Gauss Divergence theorem. (14)

Text Reference:

1. Joel R. Hass, Maurice D. Weir, George B. Thomas, Thomas' Calculus, 12th edition, Pearson , 2010.
2. Erwin Kreyszig, *"Advanced Engineering Mathematics"*, Eighth Edition, John Wiley and Sons, 2015
3. B. S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publications, 2015
4. R. K. Jain and S. R. K. Iyengar, *"Advanced Engineering Mathematics"*, Fifth Edition, Narosa Publishing House, 2016.
5. T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.

MA151	Matrices and Differential Equations	BSC	3-0-0	3 Credits

Pre-requisites: Mathematics-I

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; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices. (14)

Ordinary Differential Equations of Higher Order : 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. (14)

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem, 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. (14)

Text Reference:

1. E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, 2015.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Fifth Edition, Narosa Publishing House, 2016.
4. G. Strang, Linear Algebra and Its Applications, 4th Edition, Brooks/Cole India, 2006.
5. T. M. Apostol, Calculus, Volume 2 (2nd Edition), Wiley Eastern, 1980.

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

Pre-requisites: None.

Detailed syllabus

Grammar Principles and Vocabulary Building: -Exposure to basics of grammar- tenses—active and passive voice- their usage-Concord -Error Detection-Idioms and Phrases-Phrasal verbs—their meanings and usage, Synonyms and antonyms

Developing paragraphs using mind mapping- Definition- structure- Types and Composition-unity of theme- coherence- organization patterns-essays and their structure-note-making

Letter Writing: Formal letters-- communicative purpose-strategy- letter format and mechanics- letters of request, complaint and invitation-writing emails

Reading Comprehension –skimming-scanning-intensive and extensive reading-reading to retrieve information ——techniques of comprehension -find clues to locate important points-answering objective type questions–inference, elimination

Delegation- steps involved in delegation-preparing delegation for a program

Preparing Questionnaire-Determine audience and content of each question-response structure-develop wording for each question-establish sequence of questions

Profiling Readers-Audience analysis- Identifying potential audience- Identifying primary, secondary, tertiary readers,and gatekeepers- Identifying the needs, values, and attitude of the readers

Resume Writing-Writing for Professional Networking-Academic writing-research proposals-Interpretation of Graphs.

Technical Report-Writing - kinds of reports-proposals, progress and final reports- their structure- features- process of writing a report-editing.

Language Laboratory

Introduction to basic phonetics: Vowels, Consonants, Diphthongs, phonetic symbols

Listening: Challenges in listening, enhancing listening skills, listening activities

Speaking:JAM using cue cards-role play-Group presentation-presentation with emphasis on body language- public speaking-extempore speech

Group discussion: Dos and don’ts, intensive practice

Mock interview:Interview etiquette, common interview questions

Text Books:

Emden, Joan van. *Effective Communication for Science and Technology*. Macmillan Education UK, 2001.

Mohan, Krishna and Meera Banerji. *Developing Communication Skills*. Macmillan India Limited, 2000.

Murphy, Raymond. *Intermediate English Grammar*. Cambridge University Press, 2014.
Narayanaswami, V. R. *Strengthen Your Writing*. Orient Longman Private Limited, 2005.
Soundaraj, Francis. *Speaking and Writing for Effective Business Communication*. Macmillan Publishers India Limited, 2007.
Ur, Penny. *Discussions that Work*. Cambridge University Press, 1981.

Reference:

Aarts, Bas. *Oxford Modern English Grammar*. Oxford University Press, 2011.
Anderson, Marilyn, Pramod K. Nayar, and Madhucchanda Sen. *Critical Thinking, Academic Writing and Presentation Skills*. Pearson Education, 2008.
Blake,Gary.*The Elements of Technical Writing*. Pearson,2000
Brown, Carla L. *Essential Delegation Skills*. Routledge, 2017.
Busan, Tony. *Mind Map Mastery*. Walkins, 2018.
Carlisle, Joanne and Melinda S. Rice. *Improving Reading Comprehension Research-based Principles and Practices*. York Press, 2002.
Carter, Ronald and Michael McCarthy. *Cambridge Grammar of English: A Comprehensive Guide*. Cambridge University Press, 2006.
Carter, Ronald, Rebecca Hughes, and Michael McCarthy. *Exploring Grammar in Context: Upper-intermediate and Advanced.* Cambridge University Press, 2000.
Eastwood, John. *Oxford Guide to English Grammar*. Oxford University Press, 1994.
Harris, David.F. *Complete Guide to Writing Questionnaires.* I& M Press, 2014.
Hering, Lutz and Heike Hering. *How to Write Technical Reports: Understandable Structure, Good Design, Convincing Presentation*. Springer; 2010.
HuckinN.Thomas and Leslie A.Olsen*Technical Writing and Professional Communication for Non-native Speakers*. McGraw-Hill Education,1991.
Laplante, Phillip A. *Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals.* CRC Press, 2018.
McQuail, Dennis. *Audience Analysis*. Sage, 1997
Ogden, Richard. *Introduction to English Phonetics*. Edinburgh University Press, 2017.
Parker, Glenn M. *Team Players and Teamwork: New Strategies for Developing Successful Collaboration*. Wiley, 2011.
Seely, John. *Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly*. Oxford University Press: 2013.

PH101	Engineering Physics	BSC	3-0-0	3 Credits

Waves and Optics

Interference: Superposition principle, coherence of light, methods to produce coherent light: division of amplitude and wave front division, Young's double slit experiment: concept, working principle, and applications, Newton's ring: concept, working principle, and applications

Diffraction: Fraunhofer's single-slit diffraction, diffraction grating, and resolving power of a grating.

Polarization: Types of optical polarization, various methods to produce polarized light, working and applications of retarder plates, and half-shade polarimeter: construction and working principle.

Lasers and Optical Communication

LASER: Basic theory of LASER, Einstein's coefficients and their relations, concept of population inversion, components of lasers, modes of laser beam, construction and working principle of various types of lasers: Ruby, Helium-Neon, and semiconductor diode lasers.

Optical Fibre: Optical fibre and its working principle, total internal reflection, numerical aperture, modes of propagation, and classification of optical fibres.

Quantum Physics

Origin of quantum theory and related experiments: Black-Body radiation, photo-electric effect, and Compton effect. Heisenberg's uncertainty principle, de- Broglie's wave concept, phase and group velocities, wave function, and its properties, operators, Schrödinger's time-dependent and time-independent equations, particle in one-dimensional, infinite potential and finite potential wells, and quantum tunneling phenomena and their applications in alpha decay, and scanning tunneling microscopy (STM).

Magnetic, Superconducting and Dielectric Materials

Magnetic Materials: Introduction to Weiss theory of ferromagnetism, concepts of magnetic domains, Curie transition, hard and soft magnetic materials and their applications, magneto-resistance, GMR, and TMR.

Superconducting Materials: Introduction to superconductivity, Meissner effect, Type-I and Type-II superconductors and their applications.

Dielectric Materials: Introduction to dielectrics, dielectric constant, polarizability, frequency and temperature dependent polarization mechanism in dielectrics, dielectric loss, and applications.

Advanced Functional Materials & NDT

Smart Materials: Biomaterials, high-temperature materials and smart materials, applications of functional materials.

Nanomaterials: Introduction, classification, and properties of nanomaterials, various methods of synthesizing nanomaterials: top-down (ball milling) and bottom-up (sol-gel) approaches.

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

NDT: Methods of non-destructive testing

References:

1. A Textbook of Engineering Physics, M. N. Avadhanulu, P. G. Kshirsagar, S. Chand and Company (2015).
2. Concepts of Modern Physics, Beiser A., Mc. Graw Hill Publishers (2003).
3. Optics, Ajoy Ghatak, Tata Mc Graw Hill (2012).
4. Materials Science and Engineering: An Introduction (Tenth edition), William D. Callister, John Wiley & Sons (2018).
5. Introduction to Solid State Physics, Charles Kittel, Wiley Publishers (2011).

EC101	Basic Electronic Engineering	ESC	2 – 0 – 0	2 Credits

Detailed Syllabus:

Introduction to electronics systems, diode circuit models and applications, Zener diode as regulator, photodiode.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications. FET and MOSFET characteristics and applications.

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

Integrated Circuits: Operational amplifiers Characteristics and applications, linear operations using Op-amps.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Sequential Circuits, Analog to Digital and Digital to Analog converters (ADC/DAC).

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

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, 2nd Edition, Tata McGraw Hill, 2013.
2. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford University Press , 6th Edition
3. Leach , Malvino, Saha, Digital Principles and Applications, McGraw Hill Education , 8th Edition
4. Boylestad, Robert L., Louis Nashelsky, Electronic Devices and Circuit, Pearson , 11th Edition
5. Helfrick and Cooper, ―Modern Electronic Instrumentation and Measurement Techniques‖ PHI, 2011
6. Neil Storey, Electronics A Systems Approach, 4th Edition, Pearson Education Publishing Company Pvt Ltd.

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

Detailed Syllabus:

Introduction to Environmental Science: Environment and Societal Problems, Major - Environmental Issues, Global Climate Change Agreements, Montreal, Kyoto Protocol & Paris Agreement, Basics of Environmental Impact Assessment, Principles of Sustainability, and related indices, Population Dynamics, Urbanization. Identification and Evaluation of Emerging Environmental Issues with Air, Water, Wastewater and Solid Wastes, Introduction to Environmental Forensics.

Water & Wastewater Treatment: Water Sources, constituents, potable water quality requirements (IS 10500), overview of water treatment, sources and types of pollutants, their effects, self-purification capacity of water bodies, principles of wastewater treatment, 5R Concept.

Air & Noise Pollution: Sources, classification and their effects, national ambient air quality standards (NAAQS), air quality index, dispersion of pollutants, control of air pollution, understanding and improving indoor air quality, sources of noise pollution, effects, quantification of noise pollution.

Solid Waste Management: Sources and characteristics of solid waste, effects, 3R concept, sustainable practices in waste management, CPHEEO guidelines for solid waste management, transition to zero waste lifestyle.

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. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2006.

References:

1. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous (1985), Environmental Engineering, McGraw Hill Inc., New York
2. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, Eighth Edition, 2016.

CS101	Introduction to Algorithmic Thinking and Programming	SD	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Construct algorithms for solving problems that requires solutions involving searching, sorting, selection and / or a numerical method as a sub-routine.
CO2	Analyze the suitability of different algorithmic design paradigms for solving problems with an understanding of the time and space complexities incurred.
CO3	Construct algorithms for solving problems with an understanding of the internals of a computing system and its components like processor, memory and I/O sub-systems.
CO4	Construct efficient modular programs for implementing algorithms by leveraging suitable control structures.
CO5	Construct efficient programs by selecting and using suitable in-built Data Structures and programming language features available.

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L									
CO2	S	M	L									
CO3	S	M	L		L							
CO4	S	M	L		S							
CO5	S	M	L		S							

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Modern Computers, Hardware Components of a Computer, Data Representation in Computers, Introduction to Operating Systems, Software and Firmware, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

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

Basic Syntax in Python, Data Types, Variables, Assignments, immutable variables, Types of Operators, Expressions, Comments, Boolean Logic, Logical Operators in Python.

Conditional statements - If-else, Loops - while, for, Lazy Evaluation

Inbuilt Data Structures and their operations in Python: List, Tuples and Dictionaries.

Fundamental Algorithms: Swapping variables, Problems involving summation of a series, Sine function computation, Base Conversion, generation of sequences like Fibonacci, Reversing the digits of an integer, Character to number conversion.

Factoring Methods: Finding the square root, Finding the smallest divisor of an integer, finding the greatest common divisor using Euclid's algorithm, Computing the prime factors of an integer, generating prime numbers, Raising a number to a large power, Computation of the nth Fibonacci number.

Functions – Modular programming and benefits, user defined functions, library functions, parameter passing, Formal and Actual arguments, named arguments return values, Recursion.

Sorting algorithms: Bubble, Selection and Insertion sorts, Search algorithms: Linear and binary search

String processing: Algorithms for implementing String functions like Strlen, Strcpy, StrRev, Strcmp, Searching for a keyword or pattern in a text.

File and Directory Handling: Reading and Writing to/from a file, Formatted File creation and operations.

Simple 2D Graphics, drawing 2D objects using Turtle Graphics.

Reading List:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.

CS102	Introduction to Algorithmic Thinking and Programming Lab	SD	0 – 1 – 2	2 Credits

Pre-requisites: None

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

CO1	Construct, debug, test and run efficient programs by leveraging suitable flow of control constructs and syntactic units of the programming language.
CO2	Construct efficient programs by constructing and translating algorithms for solving problems using sorting, searching, selection and / or arithmetic computations.
CO3	Implement, refactor, test and debug functional programs in a shell-based run time environment.
CO4	Construct efficient programs by demonstrating problem-solving skills and out-of-the-box algorithmic thinking.

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L		S				M			L
CO2	S	M	L		S				M			L
CO3	S	M	L		S				M			L
CO4	S	M	L		S				M			L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

List of Experiments:

1. Familiarization with Python installation, basic syntax and running scripts in the shell.
2. Programs on conditional control constructs.
3. Programs on iterative constructs. (While, do-while, for).
4. Programs using user defined functions and in-built function calls.
5. Programs related to Recursion.
6. Programs involving in-built data structures like List, Tuples and Dictionaries.
7. Programs related to String processing.
8. Programs related to Files and I/O.
9. Implementation of Factoring methods.

10. Programs that require sorting, searching and selection as sub-routines.
11. Problems involving simple 2D graphics.
12. Implementation of a capstone application to unify the concepts learnt in the course.

Reading List:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019.
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.
3. The Python Tutorial, Available at: https://docs.python.org/3/tutorial/.

PH102	Engineering Physics Lab	BSC	0-0-2	2 Credits

List of experiments (any eight of the following):

S. No	Name of the experiment
1	Determination of Planck's constant using light emitting diode.
2	Determination of wavelength of monochromatic light in Newton's ring experiment.
3	Determination of the width of narrow slit by diffraction method.
4	Determination of wavelength of He-Ne laser using diffraction by a metal scale.
5	Determination of capacitance and time constant of a capacitor using R-C circuit.
6	Determination of wavelength of mercury spectrum by normal incidence method (diffraction grating).
7	Determination of specific rotation of an optically active material-using Laurent's half-shade polarimeter.
8	Determination of resonating frequency and bandwidth of an LCR circuit.
9	Determination of dielectric constant of various dielectric materials.
10	Studying B-H curve loop and permeability of magnetic materials.
11	Measuring spatial distribution of magnetic field between a pair of identical coils using Helmholtz coils.
12	Studying current-voltage characteristics of a photovoltaic material using solar cell.
13	Determination of numerical aperture of an optical fibre.
14	Determination of resistivities of various materials using four-probe method.

Exposure to virtual lab (any three of the following):

1. LCR – Series/Parallel

2. B-H Loop tracer

3. Planck's Constant

4. Numerical aperture of Optical Fiber

5. Newton's rings

Micro project:

This can be implemented in the subsequent semesters based on the facilities available. In the case of implementation, three or four experiments from the above listed eight experiments will be replaced with the project (~40 % of the experiments will be relaxed).

References:

1. *Physics Laboratory Manual*, School of Sciences (Physics), National Institute of Technology Andhra Pradesh (2020).

2. *Practical Physics (Electricity, Magnetism, and Electronics)*, R. K. Shukla, A Srivastava, New age international publishers (2011).

3. *B.Sc. Practical Physics*, C. L. Arora, S. Chand & Co. Ltd. (2012).

EA101	Physical Education	MSC	0-0-3	1 Credit

Detailed Syllabus:

I. Introduction to Physical Education & EAA = Sports and Games

Meaning & Definition of Physical Education, Aims & Objectives of Physical Education, Importance of Physical Education

II. Physical Fitness & Wellness Lifestyle

Meaning & Importance of Physical Fitness, Components of Physical Fitness (Cardiovascular Endurance, Strength Endurance Muscular Endurance, Flexibility, Body Composition), Components of Motor Fitness (Agility, Balance, Power, Speed, Coordination), Development of Fitness Components

III. Training Methods in Physical Education

Circuit Training (Circuit Training), Continues Training (Endurance), Interval Training (Speed & Endurance), Fartlek Training (Speed Endurance), Weight Training (Maximum Strength), Plyometric Training (Power), Flexibility Training

IV. Test & Measurements

Measurements: Height, Weight, Age, Calculation of BMI, Motor Fitness and Physical Fitness Tests (Pre - Test & Post-Test), Cardiovascular Endurance - 9/12 Minute Run or Walk, Muscular Endurance – Sit Ups for abdominal strength, Strength Endurance – Flexed arm hang for girls / Pull ups for boys, (Speed – 50m Dash or 30mts Fly Start, Strength – Broad Jump, Vertical Jump for Lower Body, Medicine Ball Put for Shoulder Strength, Endurance - 800mts, Flexibility - Bend and Reach, Agility (Coordination)) – Shuttle Run and Box Run

V. Formal Activities

Calisthenics (free hand exercises), Dumbbells, Woops, Wands, Laziums (Rhythmic activities), Aerobic Dance and Marching

VI. Sports / Games

Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, ball badminton, Kabaddi, Kho-Kho, Table Tennis, Yoga etc., Teaching & Coaching of the Game/Sport, Latest General Rules of the Game/Sport.

Specifications of Play Grounds and Related Sports Equipment

EA151	Health Education	MSC	0-0-3	1 Credit

Health Education & Personal Hygiene

Introduction & Meaning of Health Education, Definition of Health Education, Principles of Health Education, Importance of Health Education, Meaning of Personal Hygiene, Importance of Personal Hygiene, Personal cleanliness (teeth, ears, eyes, nose & throat, nails & fingers, skin, cloths, and hair).

Nutrition

Introduction of Nutrition, Balanced Diet, Daily Energy Requirements, Nutrient Balance, Nutritional Intake, Eating and Competition, Ideal Weight

First Aid & Injury Management

Introduction, Types and Principles of First Aid, Functions of First Aider, Reasons for Sports Injuries,The First Aid and Emergency Treatment in Various cases (drowning, dislocation & fractures, burns, electric shock, animal bite, snake bite, poison, etc.

Human Posture

Introduction, Meaning of Posture, types of Good Posture, causes of Poor Posture, preventive and Remedial Poor Posture, common Postural Deformities, Body Types, Advantages of Good Posture

Yoga

Introduction, Meaning & Importance of Yoga, Elements of Yoga, Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas, Yoga for concentration & related Asanas (standing asanas, sitting asanas, supine and prone postures.), Relaxation Techniques for improving concentration – Yoga – nidra, Pranayama

Sports / Games

Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, ball badminton, Kabaddi, Kho-Kho, Table Tennis, Yoga etc.,Teaching & Coaching of the Game/Sport., Latest General Rules of the Game/Sport, Specifications of Play Grounds and Related Sports Equipment.

ME102	Engineering Graphics with Computer Aided Drafting	ESC	2-0-0	2 Credits

Note: 50% of the Practice through manual drawing and 50% of the Practice through a Computer Aided Drafting Package.

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Construction of Polygons, Scales. Introduction to Computer Aided Drafting (CAD), DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES, etc.

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

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.

Sections 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.

Reading:

1. N.D. Bhatt and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.

2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23 rd Edition, 2016.

CY101	Engineering Chemistry	BSC	3-0-0	3 Credits

Basic Organic Chemistry

Reaction intermediates: carbocations, carbanions, free radicals and carbenes. Classification of organic reactions, examples and their mechanisms: substitution, addition, elimination and rearrangement reactions. Reimer–Tiemann reaction, Kolbe-Schmidt reaction, Cannizzaro reaction. Pinacol-Pinacolone, Hofmann and Beckmann rearrangements. Diels-Alder reaction.

Spectroscopic Techniques for Chemical Analysis

Introduction of spectroscopy, Quantum aspects of electronic, vibrational and nuclear energy levels. UV-Visible spectroscopy: Principle, Instrumentation, Beer-Lambert's law, Effect of conjugation, Woodward-Fieser empirical rules for acyclic/cyclic dienes. IR spectroscopy: Principle, Factors that affect vibrational frequencies and functional group detection. Proton NMR spectroscopy: Principle, Instrumentation, Chemical equivalency, Chemical shift and spin-spin splitting. Applications of UV-Vis, IR and proton-NMR spectroscopy in determining the structure of small organic molecules.

Coordination Chemistry

Introduction of coordination chemistry, Valence bond (VB) theory and shapes of Inorganic Compounds, Spectrochemical series, Crystal Field theory (CFT): octahedral and tetrahedral complexes, Crystal field splitting energy (CFSE); Molecular Orbital (MO) Theory: Molecular orbital diagrams for octahedral complexes (strong and weak ligand fields).

Electrochemistry

Electrodes, Electrochemical Cells, Electrochemical series and Nernst equation; Conductometry and Potentiometry; Batteries: Types of batteries, Ni-Cd and Lithium (Li)-ion batteries; Fuel Cells: Hydrogen-Oxygen, Methanol-Oxygen fuel cells; Corrosion - Theories of corrosion, Wet corrosion, Types of wet corrosion, Factors affecting the rate of corrosion, Corrosion control methods: Sacrificial anode method and Impressed current method.

Engineering Materials and Applications

Polymers: Introduction, Types of polymerization, Functionality in polymers, Number and Weight average molecular weight, Polydispersity index, Biodegradable polymers; Conductive polymers: classification, examples and applications; Organic light emitting diode (OLED): structure, principle and applications; Optical fibres: principle and Applications.

Reference books:

1. Organic Chemistry, Clayden, Greaves, Warren and Wothers, Oxford University Press, 2014.
2. Organic Spectroscopy, William Kemp, 2nd edition, Macmillan publishers, 2019.

3. Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo and Manfred Bochmann, 6th Edition, 1988.
4. Physical Chemistry, P. Atkins and Julio de Paula, 8th Edition, Freeman & Co. 2017.
5. A Textbook of Engineering Chemistry, Shashi Chawla, 2017.
6. Polymer Science and Technology, Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010.

EE101	Elements of Electrical Engineering	ESC	2-0-0	2 Credits

Detailed Syllabus

Basic Concepts

Electric Charge, Current and Electromotive force, Potential and Potential Difference; Electrical Power and Energy; Ohm's Law, Resistance, Capacitance and Inductance, Series and Parallel Connection of Resistances and Capacitances, Kirchoff's Laws and Their Applications

AC Fundamentals:

Concept of Alternating Voltage and Current, RMS and Average Values, Single Phase and Three Phase Supply; 3-ph Star-Delta connections, Alternating Voltage applied to Pure Resistance, Inductance, Capacitance and their combinations, Concept of Power and Power Factor in AC Circuit.

Measuring Instruments:

Principle and Construction of Instruments used for Measuring Current, Voltage, Power and Energy, Methods and precautions in use of these.

Electromagnetic Induction:

Concept of Magnetic Field, Magnetic Flux, Reluctance, Magneto Motive Force (MMF), Permeability; Self and Mutual Induction, Basic Electromagnetic laws, various losses in magnetic circuits;

Electrical Machines:

Elementary concepts of an electrical machine, Basic principle of a motor and a generator, Classification of Electrical machines; Principles, Construction and Working of a machine; Starters: Need, Construction and Operation; Transformer: Classification, Principles, Construction and Working of a Transformer, Applications of Transformers;

Utilization of Electricity:

Utilization concepts of Electricity for electrolysis process, Electrochemical Cells & Batteries; Application of Electricity, Energy Conversation and Efficiency

Basic Troubleshooting:

Basic Testing and faults diagnosis in electrical systems, various tools and their applications, replacement of different passive components.

Electrical Safety:

Electrical Shock and Precautions against it, Treatment of Electric Shock; Concept of Fuses and Their Classification, Selection and Application; Concept of Earthing.

Reading:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12 th Edition, 2016.

2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2 nd 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.

5. B.L.Theraja , Fundamentals of Electrical Engineering and Electronics volume -I, S Chand & Company 2005.

6. Ashfaq Husain, Fundamentals of Electrical Engineering, Dhanpat Rai & Sons 4 th edition, 2010.

7. H.Partab: Art & Science of Utilization of Electric Energy, Dhanpat Rai & Sons, 1998.

8. Fundamentals of Electrical Circuits by Charles k.Alexander, Mattew N.O.Saidiku, Tata McGraw Hill company.

BT101	BIOLOGY FOR ENGINEERS	ESC	2-0-0	2 Credits

Pre-requisites: None

Detailed Syllabus:

Importance of biology to engineers, Molecules of life: Water and Carbon, Evolution and origin of life, Darwins theory, Diversity of life, Chemical basis of life, Nucleic acids, Amino acids and Proteins, Carbohydrates, Lipids and Membranes.

Cell structure and function:

Prokaryotic, Eukaryotic cell and Virus, Sub cellular organelles and their functions, Regulation of cellular metabolism: Cellular respiration and Fermentation, Photosynthesis, Cell division (differences between mitosis and meiosis), Mendel's Law and Patterns of inheritance.

Gene structure and expression

Difference between prokaryotic and eukaryotic gene structure, DNA replication, Transcription, RNA processing and Translation, Control of gene expression (lac operon).

Applications of Biology in Engineering

Genetic engineering (microbe, plant and animal cells for improvement), Industrial Biotechnology (Primary and Secondary metabolites), Environmental engineering, Biopharmaceuticals, Tissue engineering, Biomaterials, Stem cell engineering, Biosensors, Bioinformatics.

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.

ME101	Basics of Mechanical Engineering	ESC	2-0-0	2 Credits

Detailed Syllabus:

Evolution of Mechanical Engineering: Introduction, Definition and scope of Mechanical Engineering, relation of Mechanical Engineering with other Engineering Disciplines, Revolutionary Inventions in wheels, tools, windmills, steam engine, CNC machines, Rapid Prototyping, Air-conditioning and Refrigeration, History of Mechanics, Thermodynamics and Heat Transfer, Production and Industrial Engineering, Mechatronics.

Engineering Materials: Introduction to Engineering Materials, Classification and Properties, Alloys. Composites, Micro and Nano Materials.

Manufacturing Processes: Castings - Patterns & Moulding, Metal forming, Hot Working and Cold Working Extrusion, Drawing, Rolling, Forging. Welding - Arc Welding & Gas Welding, Soldering, Brazing. Introduction to Machining processes – Lathe, Milling, Shaping, Drilling, Grinding, 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: Introduction to Energy Sources - Thermodynamics - System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law - Cyclic process, Change of State, Cp, Cv, 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.

Introduction to Steam Turbines and I.C. Engines: I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences.

Introduction to Heat Transfer and Refrigeration: Vapor Compression Refrigeration Cycle - Refrigerants, Desirable Properties of Refrigerants. Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems.

Reading:

1. Dixit, U.S., Hazarika, M. and Davim, J.P, A Brief History of Mechanical Engineering, Springer, 2017.
2. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2008.
3. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
4. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
5. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, NemChand Brothers, New Delhi, 1994.
6. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

CE101	Engineering Mechanics	ESC	2-0-0	2 Credits

Prerequisites: None

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,

Equillibrium of force system- Degrees of freedom - Equilibrium Equations, Degree of Constraints – Free body diagrams.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems

Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of members.

Friction in rigid bodies- Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

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

Dynamics of Particles – Introduction to kinematics- Equations of rectilinear motion, D'Alembert's principle -Simple problems- Introduction to kinetics- Work and Energy.

Reading:

1. J.L.Meriam, L.G. Kraige, Engineering Mechanics, Statics, John Wiley &Sons,7th Edition, 2012.
2. A.K. Tayal, Engineering Mechanics, Umesh Publications, 14th Edition, 2010.
3. S S Bhavikatti and K G Rajashekarappa, Engineering Mechanics, New Age International Publication, 4th Edition.

Reference:

1. Dietmar Gross, Werner Hauger, Jorg Schroder, Wolfgang A. Wall, Nimal Rajapakse, Engineering Mechanics 1, Statics, Springer, 2nd Edition, 2013.

S. Timoshenko, D.H. Young, Pati Sukumar, J V Rao, Engineering Mechanics, Mc-Graw Hill, 5th Edition.

ME103	Workshop Practice	SD	0-1-2	2 Credits

Detailed Syllabus:

Fitting Shop: 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.

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 Shaping operation. 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 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.

Welding: Study of welding tools and welding equipment, Arc Welding Practice (Lap and Butt joint).

CY102	Engineering Chemistry Lab	BSC	0-0-2	2 Credits

List of experiments (any eight of the following):

Exp. No	Name of the experiment
1	Standardization of $KMnO_4$ solution
2	Determination of Iron in Haematite
3	Determination of Hardness of Water
4	Determination of available chlorine in bleaching powder and of iodine in Iodized salt
5	pH-metric titration of an acid vs a base
6	Conductometric titration of an acid vs a base
7	Potentiometric titration of Fe^{2+} against $K_2Cr_2O_7$
8	Colorimetric determination of Potassium Permanganate
9	Determination of rate of Corrosion of mild steel in acidic environment in the absence of presence of an inhibitor
10	Determination of Chlorophyll in Olive oil by using UV and Fluorescence spectroscopic techniques
11	Functional group analysis of organic compounds by using IR spectroscopic technique
12	Organic solvent evaporation by using rotary-evaporation technique

Virtual labs

1. Determination of unknown concentration of analyte by using the Beer-Lambert's law.
2. Identification of unknown components using spectroscopic techniques.
3. Nuclear magnetic resonance spectroscopy and evolution of simple ^1H NMR spectra of organic compounds
4. Study of kinetics of a reaction by using spectrophotometric methods.

Reference books:

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.

Department of Civil Engineering

IInd Year Course Syllabus

MA203	Mathematical Methods	BSC	3-0-0	3 Credit

Prerequisites	Differential & Integral Calculus (MA101), Matrices & Differential Equations (MA151).
Course Outcomes	At the end of the course, the student will be able to
CO1	Determine Fourier series expansion of a given function
CO2	Solve PDEs by variables separable method
CO3	Understand and use of complex variables and evaluation of real integrals
CO4	Test the hypothesis for large and small samples

Detailed Syllabus :

Fourier Series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions.

Partial Differential Equations: Method of separation of variables - Solution of one-dimensional wave equation, one dimensional heat conduction equation and two dimensional steady state heat conduction equation with illustrations.

Complex Variables: Analytic function - Cauchy Riemann equations - Harmonic functions - Conjugate functions - complex integration - line integrals in complex plane - Cauchy's theorem (simple proof only), Cauchy's integral formula - Taylor's and Laurent's series expansions, Conformal mapping.

Probability and Statistics: Random variables, Discrete and continuous 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 – Karl Pearson Coefficient of correlation – Lines of regression.

Readings:

1. R.K. Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics,* Narosa Publishing House, 5th edition, 2016.
2. E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 8th edition, 2008.
3. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications,44th edition, 2017.
4. S.C.Gupta and V.K.Kapoor, *Fundamentals of Mathematical Statistics*, S.Chand & Co, 2006.

Reference:

1. M. Spiegel, S. Lipschutz , J. Schiller, and D. Spellman, *Complex Variable (Schaum's Outlines)*, Revised 2nd edition, 2017.

CE 201	Strength of Materials -I	PCC	3-1-2	5 Credit
Prerequisites	CE101- Engineering Mechanics			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Analyse the statically determinate and indeterminate problems			
CO2	Draw shear force and bending moment diagrams for statically determinate beams.			
CO3	Determine the stresses and strains in the members subjected to axial, bending and torsional loads			
CO4	Evaluate the slope and deflection of beams subjected to loads.			
Detailed Syllabus :				
Unit 1: Stress and Strain: Concept of static determinacy and indeterminacy- Determinate and Indeterminate problems in Tension and Compression - Thermal Stresses. **Unit 2:** Elastic Constants and Impact Loading: Stress-strain diagrams for brittle and ductile materials -working stress - Impact loading - pure shear - Modulus of rigidity and Bulk modulus - Relation between E, G and K. **Unit 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. **Unit 4:** Theory of Simple Bending: Assumptions - Theory of Simple Bending - Bending stresses in beams - Discussion of efficiency of various shapes of cross sections - Flitched beams, Unsymmetrical bending of straight beams **Unit 5:** Shear Stress Distribution: Flexural shear stress distribution in various shapes of cross section of beams. **Unit 6:** Torsion of Circular Shafts: Theory of Pure Torsion in Solid and Hollow circular shafts - Torsional Shear Stresses and angle of twist - transmission of Power. **Unit 7:** Deflection of Beams: Double Integration method, Macaulay's method, Moment area method, Conjugate Beam method - Calculation of Slope and deflections of statically determinate beams.				
Readings:				
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.				
5. B.C.Punmia, Strength of Materials, Laxmi Publications Pvt. Ltd., 2018				

Material Testing Laboratory
1. To study the stress-strain characteristics of (a) Mild Steel (b) Tor steel by conducting tension test on U.T.M
2. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper by conducting hardness test.
3. To determine the Modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft
4. To find the Modulus of rigidity of the material of a spring by conducting Compression test.
5. To determine the young's modulus of the material by conducting deflection test on a simply supported beam.
6. To determine the Modulus of elasticity of the material by conducting deflection test on a Propped Cantilever beam.
7. To determine the Modulus of elasticity of the material by conducting deflection test on a continuous beam
8. Impact test for Steel
9. Shear test on Mild Steel rods
Reference:
1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.

CE 202	Fluid Mechanics	PCC	3-0-2	4 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Understand the fluid properties and their importance in solving various Engineering problems
CO2	Understand the conservation laws and apply them 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 and design of pipe networks

Detailed Syllabus :

Introduction: Purpose of study of fluid mechanics for design and operation of engineering systems in the fields of Civil and allied Engineering, Fundamental difference between a solid and a fluid, constituent relationships for solids and fluids, conservation principles applied in fluid mechanics. Properties of fluids, Concept of continuum, viscosity, compressibility, Types of fluids, surface tension, cavitation.

Fluid Statics and Kinematics: Pascal's law, hydrostatic law, Pressure measurement and devices, Hydrostatic forces exerted on submerged surfaces, Buoyancy, Fluid Kinematics**,** Fluid Flow Visualization, Types of fluid flows, Velocity field, one & two-dimensional flow analysis, stream function and velocity potential function, potential flow, flownet analysis.

Fluid Dynamics: control mass & control volume approach, Reynolds transport theorem, Steady flow and uniform flow, 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.

Dimensional Analysis: DA as a tool in design of experiments, identification of non-dimensional numbers and their significance, dimensional analysis methods

Flow Through Pipes and Other conduits: Measurement of flow in pipes, uses of orificemeter and venturimeter, Major and Minor losses, head loss in flow through pipes, Darcy Weisbach equation, losses in pipe transitions, Flow measurements in open channels and tanks.

Laminar and Turbulent Flows: Laminar flow and its characteristics, Laminar flow between parallel plates, Laminar flow through pipes, Hazen-Poiseuille equation, Reynolds experiment, Turbulence, Prandtl's mixing length theory, Velocity distribution in turbulent flow, pipe networks.

Readings:

1. Hydraulics and Fluid Mechanics by PN Modi and SN Seth, Standard Book House, New Delhi.

2. Fluid Mechanics Including Hydraulic Machines by A K Jain, by Khanna Publishers, New Delhi.
3. F M White, Fluid Mechanics, Tata McGraw Hill Publication 2011.
4. Streeter V.L., Benjamin Wylie, Fluid Mechanics, McGraw Hill Book Co., New Delhi, 1999.
5. Garde, R.J. Fluid Mechanics through Problems Wiley Eastern Limited, New Delhi, India, 1989

Fluid Mechanics Laboratory				
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. Determination of Darcy's friction factor, relative roughness for laminar and turbulent flows.				
5. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades and Pelton bucket.				
Reference:				

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

CE 203	Environmental Engineering - I	PCC	3-0-0	3 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Analyse the 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	Effects of Air and Noise Pollution and Identify Appropriate Control Devices

Detailed Syllabus :

Unit -1: Water Sources - Quality and Quantity of Water - Intake - Factors Governing Location of Intakes - Transportation of Water - Characteristics (Physical, Chemical and Biological) - Standards - Water Borne Diseases - Natural Purification of Water Sources – Types of Water Demand - Fluctuations - Design Period - Population Forecasting Methods.

Unit 2: Distribution System -Requirements - Methods - Layout & Design - Appurtenances - Analysis of Pipe Networks - Types of Pipes - Pipe Appurtenances - Pumps - Pumps - Types of Conduits for Water Conveyance.

Unit 3: Water Treatment - Unit Operation & Processes, Processes (Sedimentation, Coagulation -Flocculation, Softening, Disinfection, Adsorption, Ion Exchange, Filtration) - Disinfection - Advanced Treatment - Design Aspects - Water Conservation - Rainwater Harvesting.

Unit 4: Air & Noise Pollution: Air Pollution (Health Effects, Regulatory Standards, Dispersion; Stacks, Control Systems); Noise pollution: Types of Noise – Impacts - Permissible Limits - Measurement of Noise - Control Measures.

Readings:

1. CPHEEO Manual on Water Supply and Treatment, 1999
2. S.K. Garg (1999), Water Supply Engineering – Environmental Engineering (Vol. I) – Khanna Publishers.
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. C. N Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineers, McGraw - Hill, 1994.

CE 204	Engineering Geology & Surveying	PCC	3-0-0	3 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Understand weathering process and mass movement
CO2	Identify geological formations and structures for rock mass quality assessment
CO3	Know different instruments and techniques to determine the positions on the surface of the earth.
CO4	Capture geodetic data to process and perform analysis for the survey problems with the use of electronic instruments

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 & Petrology: Physical properties in mineral identification, rock forming minerals and their identification - Formation and classification of rocks – Drilling Techniques, Core Recovery, RQD, Engineering Properties of Rocks
3. Structural Geology: Geological Map, outcrop, attitude of beds, types and classifications of folds, faults, joints, unconformities.
4. Introduction to Surveying - plane surveying, principles and classification, scales, Errors and Mistakes; Basic Surveying instruments: Concepts of Chain Surveying, Compass surveying and Plane Table surveying, Principles and methods.
5. Levelling and Contouring: Description of a point (position) on the earth's surface, instruments for levelling, principle and classification of levelling, bench marks, levelling staff, readings and booking of levels, field work, plotting the profile, height (level) computations, contours, characteristics of contours, methods of contouring, interpolation, contour gradient, contour maps
6. Advanced Surveying: Principle of EDM, Features and Functions of Total Station, Global Positioning System – Segments, Positioning methods, Errors, Applications
7. Introduction to Photogrammetry: Geometric Concepts, Analysis of the single photograph, Relief Displacement, Parallax, Stereoscopy, Photogrammetric Products, Introduction to UAV systems.

Readings:

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. Surveying (Vol. 1 & 2) by Dr. KR Arora, Published by standard book house
4. James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012.
5. Chandra A. M., Higher Surveying, New Age International Publishers, 2007
6. Surveying (Vol. 1 & 2) by B.C.Punmia, Laxmi Publications Pvt. Ltd

CE 205	Surveying Laboratory	PCC	0-0-2	1 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the 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

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

Readings:

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

CE 206	Environmental Engineering Laboratory	PCC	0-0-2	1 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Determine physical and chemical characteristics of water
CO2	Determine optimum dosage of coagulant
CO3	Determine break - point chlorination
CO4	Assess the quality of water

Detailed Syllabus:

1. Physical Characteristics of Water:
   - Turbidity, Taste, Odor, Color, Electrical Conductivity;
2. Analysis Of Solids Content of Water:
   - Dissolved, Settleable, Suspended, Total, Volatile, Inorganic; Alkalinity and Acidity; Hardness - Total, Calcium and Magnesium;
3. Optimum Coagulant Dose;
4. Break Point Chlorination

Readings:

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.

CE 251	Strength of Materials - II	PCC	4-0-0	4 Credit

Prerequisites	CE 211- Strength of Materials-I

Course Outcomes	At the end of the course, the student will be able to
CO1	Understand strain energy concepts for different conditions
CO2	Determine principal stress and strains
CO3	Analyse columns and struts
CO4	Understand the concept of failure theories and analyse springs
CO5	Determine the stress and strains in thin cylinders and thin spherical shells.

Detailed Syllabus:

1. Strain Energy Introduction; Elastic strain energy for uni-axial stress; elastic strain energy in pure bending; Strain energy of beams in shear; Strain energy of circular shafts in torsion; strain energy for multiaxial state of stress Castigliano's Theorem I - application to statically determinate beams for determining slopes and deflections
2. 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.
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. 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.
5. 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.
6. Shear Centre: Concept of Shear Centre – Shear Centre of various cross sections – Shear flow – Shear lag.
7. Thin Cylinders & Thin spherical shells: Internal fluid pressure – Wire wound thin cylinders

Readings:

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.
5. B.C.Punmia, Strength of Materials, Laxmi Publications Pvt. Ltd., 2018

CE 252	Open Channel Hydraulics	PCC	3-0-0	3 Credit

Prerequisites	CE 212-Fluid Mechanics

Course Outcomes	At the end of the course, the student will be able to
CO1	Compute drag and lift coefficients using the theory of boundary layer flows
CO2	Design of open channels
CO3	Compute the flow profiles in open channel flow
CO4	Design experimental procedure for physical model studies

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. ***Introduction to Open Channel Flow:*** Pipe flow vs Open Channel flow, Classification of open channels and types flows, Basic Equations used in OCF.
3. ***Uniform Flow:*** formulae, Concept of Specific energy, Specific Energy diagram and its applications, Critical, sub critical and super critical flows, Channel transitions, best hydraulic sections
4. ***Non-Uniform Flow:*** Steady Gradually Varied Flow, gradually varied flow equation, Type of GVF profiles, Computation of GVF profiles.
5. ***Steady Rapidly Varied Flow:*** Hydraulic jump in a horizontal rectangular channel, Specific force, Computation of energy loss.
6. **H*ydraulic Similitude and Design of open channels:*** Review of dimensional analysis, Similarity laws, Model studies, Rigid boundary and Mobile boundary channel design.

Readings:

1. Subramnaya, K., Flow in Open Channel, Tata McGraw Hill Publications, New Delhi, 2008.
2. A text book of Open Channel Flow by Madan Mohan Das, PHI publications, New Delhi.
3. Chow V.T. Open Channel Hydraulics, Blackburn Press, 2009.
4. F M White, Fluid Mechanics, Tata McGraw Hill Publication 2011.
5. P.N. MODI, S.M. SETH, Hydraulics and Fluid Mechanics Including Hydraulics Machines Standard Book House 2018

CE 253	Geotechnical Engineering -I	PCC	4-0-0	4 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Characterize and classify soils
CO2	Understand the effective stress principle under various field conditions
CO3	Understand the principles of compaction and stress distribution under applied loads.
CO4	Analyse and compute the consolidation settlements
CO5	Determination of the shear strength parameters

Detailed Syllabus:

1. Introduction: Soil formation- Major soil deposits of India. Basic Definitions and Relationships: 3-phase soil system, Volumetric relationships, and weight -volume relationships. Determination of Index Properties: Water content, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg limits and indices. 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.
2. 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-Flow nets, Quicksand condition.
3. 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. 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.
4. 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.
5. 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. Skempton's pore pressure parameters. Introduction to stress paths.
Readings:
1. Gopal Ranjan and A.S.R. Rao, "Basic and Applied Soil Mechanics", Wiley Eastern Ltd., New Delhi, 2016.
2. V.N.S. Murthy, "Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundatio'n Engineering", CBS Publishers, New Delhi. 2007.
3. K.R.Arora, "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, Delhi, 2004.
4. Kaniraj S. R, Design Aids in Soil Mechanics and Foundation Engineering, McGraw Hill Education 2017

Reference:
1. R.F. Craig, "Criag's Soil Mechanics", CRC Press, 2012
2. T.W. Lambe and R.V. Whitman, "Soil Mechanics", John Wiley & Sons, New York, 1969.
3. K. Terzaghi, R.B. Peck and G. Mesri, "Soil Mechanics in Engineering Practice", John Wiley & Sons, New York, 1995.

CE 254	Building Materials & Concrete Technology	PCC	4-0-0	4 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Understand importance of the stones, bricks and timber as construction materials
CO2	Identify Quality Control tests on concrete making materials
CO3	Understand the behaviour of fresh and hardened concrete
CO4	Design concrete mixes as per IS and ACI codes
CO5	Understand the durability requirements of concrete

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. 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.
4. Lime and Cement: IS classification of lime and uses, flow diagram of manufacturing process of cements, chemical composition of cement
   Hydration of Cement: Bogue's compounds, Hydration, Gel formation, Types of cement, pore & capillary water, Quality tests on cement: Different test on cement as per Indian standards
5. Aggregates: Tests on aggregates as per Indian standards, Bulking of sand, Sieve analysis, Grading.
6. Fresh concrete: Properties of fresh concrete- Workability – different tests of workability, Factors influencing workability compaction, finishing, curing.
7. Hardened concrete: Tests on hardened concrete as per IS codes – Relationship between different strengths – factors influencing strength, NDT techniques.
8. Durability: Factors influencing durability – Chemical effects on concrete- Carbonation, Sulphate attack, Chloride attack.
9. Concrete Mix design: Different methods of mix design – factors affecting mix design – exercises.
10. Special concrete: Heavy density concrete, underwater concrete, self-compacting concrete, light weight concrete etc.

Readings:

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

CE 255	Engineering Hydrology	PCC	3-0-0	3 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Analyse hydro-meteorological data
CO2	Estimate abstractions from precipitation
CO3	Compute yield from surface and subsurface basin
CO4	Formulate and solve hydrologic flood routing models

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, Derivation of unit hydrograph for ungauged catchments, synthetic unit hydrograph and its derivation.
6. **Floods Estimation and Routing:** Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting.

Readings:

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.

CE 256	Hydraulic Engineering Laboratory	PCC	0-0-2	1 Credit
Prerequisites	CE 212- Fluid Mechanics & CE 222 Open Channel Hydraulics			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Compute drag coefficients			
CO2	Determine Manning's and Chezy's coefficients for smooth and rough channels			
CO3	Determine energy loss in hydraulic jump			
CO4	Develop procedure for standardization of experiments			

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

Readings:

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

CE 257	Concrete Technology Laboratory	PCC	0-0-2	1 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Identify Quality Control tests on concrete making materials
CO2	Understand the behaviour of fresh and hardened concrete
CO3	Design concrete mixes as per IS code

Detailed Syllabus:

1. Determination of Fineness 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 Course and Fine Aggregates.
6. Determination of percentage of voids, Bulk density, Specific Gravity of course 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.

Readings:

1. Concrete Technology – M. S. Shetty – S Chand Co., Publishers – 2006.
2. Concrete Technology – M. L. Gambhir – Tata Mc Graw Hill Publishers – 2012.
3. IS 10262:2019 Code of Practice for Mix design of concrete

Department of Civil Engineering

IIIrd Year Course Syllabus

CE301	STRUCTURAL ANALYSIS-I	PCC	3-0-0	3 Credits

Prerequisites	CE 251- Strength of Materials-II
Course Outcomes	At the end of the course, the student will be able to:
CO1	Formulate Equilibrium and compatibility equations for structural members.
CO2	Analyze indeterminate frames using Moment distribution and slope deflection methods.
CO3	Analyze indeterminate truss systems using energy methods.
CO4	Analyze structures for moving loads by applying the concepts of influence line diagram.

Detailed Syllabus:

1. **Method of consistent deformation**: 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. **Slope - Deflection Method**: Analysis and application to continuous beams - portal frames (single bay - Single storey).
3. **Moment-Distribution Method**: Analysis of continuous beams and portal frames (single storey single bay).
4. **Analysis of pin jointed frames** (one degree redundancy); Forces in indeterminate pin jointed frames due to temperature variation and lack of fit;
5. **Influence lines and Moving Loads for beams**: 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 and Moving Loads for trusses**: Influence lines for simple trusses, Muller - Breslau Principle, Influence lines for reactions, shear force at a point and bending moment at a section of beams with fixed ends and two span continuous beams.

Readings:

1. R.C. Hibbeler, Structural Analysis, 8th Edition, Pearson Education
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.
4. L.S. Negi, Theory and Problems in Structural Analysis, Tata McGraw Hill Pub, 1997.
5. Reddy C.S.- Basic Structural Analysis - Tata McGraw- Hill Publishing Company Ltd.

CE302	GEOTECHNICAL ENGINEERING-II	PCC	3-0-0	3 Credits

Prerequisites	CE 253 - Geotechnical Engineering – I

Course Outcomes	At the end of the course, the student will be able to:
CO1	Understand soil exploration methods
CO2	Analyze the stability of slopes
CO3	Determine the earth pressures on foundations and retaining structures
CO4	Calculate the bearing capacity of soils and foundation settlements
CO5	Analyze pile foundations

Detailed Syllabus:

1. **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.
2. **Stability of Soil Slopes**: Types of slopes – Types of slope failures – Slip circle method, Determination of centre of critical slip circle – Taylor's stability charts and their use, Stabilization of soil slopes
3. **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
4. **Shallow Foundations and Bearing Capacity**: Types of shallow foundations and choice, basic requirements, Significance of these foundations. 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. 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.
5. **Deep Foundations** – types of deep foundations, 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.

Readings:

1. Das, BM (2009): Geotechnical engineering – Cengage learning, New Delhi.
2. Gopal Ranjan, Rao ASR (2000): Basic and applied soil mechanics – New age publication, Delhi.
3. Geotechnical Engineering by C. Venkataramiah, New age international publishers, New Delhi, 2006.

References:
1. Analysis and Design of Substructure (Limit State Design) by Swami Saran
2. Earth pressure and Earth-Retaining Structures by C.R.I. Clayton, R.I. Woods, A.J. Bond and J. Milititsky, CRC press, London, 2013.
3. Foundations and Earth Retaining Structures by Muni Budhu, John Wiley & Sons, 2008.
4. Foundation Engineering by P.C. Varghese, PHI Learning, ISBN: 9788120326521.
5. Analysis and Design of Substructure (Limit State Design) by Swami Saran

CE 303	DESIGN OF CONCRETE STRUCTURES	PCC	3-1-0	4 Credit

Prerequisites	CE 251 - Strength of Materials-II
Course Outcomes	At the end of the course, the student will be able to
CO1	Understand and apply the concepts of limit state design and working stress methods
CO2	Design Reinforced Concrete slabs and beams
CO3	Design the Reinforced Concrete Columns and footings
CO4	Design structures for serviceability
CO5	Design of stair case, retaining wall and water tank

Detailed Syllabus:

1. Design philosophy - Working stress and limit state methods
2. Design of RC beam sections for flexure using working stress method
3. Design of RC beam sections for flexure, shear and torsion using limit state methods
4. Design of RC beam elements - detailing, curtailment and serviceability
5. Design of one-way slabs, design of two-way slabs, design of slabs for serviceability, design of continuous slab systems.
6. Design of short columns under pure compression, design of short columns under compression, and uniaxial and biaxial bending
7. Principles of structural design of footings, design of isolated RC footings
8. Design of cantilever Retaining walls- Design of RC Circular Water tank.

Readings:

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

CE 304	IRRIGATION ENGINEERING	PCC	3-1-0	4 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Plan an Irrigation System
CO2	Design of irrigation canals and canal network
CO3	Plan and design of diversion head works
CO4	Design irrigation canal structures
CO5	Analyze the storage head works and energy dissipators

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
4. **Design of diversion head works**: Types of hydraulic structures, Layout of a diversion head work, Design of vertical drop weir, Silt control in head works
5. **Design of Canal Structures**: Canal regulators, Types of canal falls, Design of Sarda type fall, Types of cross drainage works.
6. **Storage head works**: Types of storage head works, Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam Earth dams: Types of earth dams, Causes of failure of earth dams, Seepage analysis, Seepage control, Stability analysis
7. **Spillways and energy dissipation systems**: Types of spillways, Ogee spillway, Principles of energy dissipators

Readings:

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

CE 305	Geotechnical Engineering Laboratory	PCC	0-0-2	1 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Determine index properties of soils			
CO2	Classify soils			
CO3	Determine engineering properties of soils			
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 10. Consolidation Test.				
Readings:				
1. IS Codes; ASTM Codes				
2. Gopal Ranjan, Rao ASR (2000): Basic and applied soil mechanics – New age publication, Delhi.				

CE 306	BUILDING DRAWING	PCC	0-0-2	1 Credit
Prerequisites	ME102 - Engineering Graphics			
Course Outcomes	At the end of the course, the 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			
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, retainingwall, dams, pipelines, water tanks etc., with design notations. 5. Drawing various plans and elevations, isometric view & perspective view of civilengineering structures. 6. Executing a spiral and other type of stair case in 3D. 7. Drawing & detailing of steel & RC structures				
Readings:				
1. AutoCAD Manual				

CE 351	TRANSPORTATION ENGINEERING-I	PCC	3-0-0	3 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. Highway Network Planning: classification of transportation systems, role of highway transportation, road network patterns, road development plans, master plan.
2. Highway Alignment and Geometric Design: Principles of highway alignment, requirements, controlling factors, engineering surveys, importance of geometric design, design controls and criteria, cross-sectional elements, sight distance, design of horizontal and vertical alignment, integration of horizontal and vertical alignment.
3. 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.
4. Analysis and Design of Pavements: Introduction to analysis of pavement structures and design considerations, Design of flexible pavement using IRC method; Design of rigid pavements using IRC method.
5. Traffic Engineering Principles: Traffic characteristics; components of traffic stream: flow- speed-Density, measurement and analysis, q-k-v relationships, concept of PCU, capacity and level of service, traffic signs; types of intersections, signal design by Webster's method, road safety.

Readings:

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 Pt. Ltd, New Delhi, India, 2017.
4. Yoder, E.J. and M.W. Witczak. Principles of Pavement Design, Second Edition, John Wiley and Sons, New York, USA, 2012.

CE 352	ENVIRONMENTAL ENGINEERING - II	PCC	4-0-0	4 Credit

Prerequisites	CE 203 - Environmental Engineering I

Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. **Quality and Quantity Perspectives of wastewater:** Characteristics of wastewater (Physical, chemical and biological) – Analysis - Importance of BOD and COD - Effluent standards - Disposal Methods - 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**: Indian waste management scenario: Consumerism and our throw-away culture, Characteristics of MSW, Elements of solid waste management, engineered systems for solid waste management, Disposal of MSW, Hazardous waste, Biomedical and e-waste disposal.

Readings:

1. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous (1985), Environmental Engineering, McGraw Hill Inc., New York.
2. S.K. Garg (1999), Sewage Disposal and Air Pollution Engineering – Environmental Engineering (Vol.II) – Khanna Publishers.

3. Metcalf & Eddy, Inc. (2003), Waste water Engineering Treatment and Reuse, McGraw Hill Inc., New Delhi.
4. Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993
5. CPHEEO Manual on sewerage and sewage treatment systems, 2013

CE 353	Transportation Engineering Laboratory	PCC	0-0-2	1 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. **Tests on Aggregate:** aggregate gradation, combined flakiness and elongation test, specific gravity test, water absorption test, impact test, crushing strength test, Los Angeles abrasion test, stripping value of aggregates, demonstration of soundness test.
2. **Tests on Bitumen:** penetration test, flash and fire point test, 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, 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, dynamic cone penetrometer test, and pavement layer density using sand replacement method.
6. **Traffic Studies:** speed studies, headway distribution studies, speed-volume studies, and parking studies.

Readings:

1. Khanna, S.K., Justo, C.E.G. and Veeraragavan, A. 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, MoRTH Specifications.

CE 361	STRUCTURAL ANALYSIS-II	DEC	3-0-0	3 Credit

Prerequisites	CE301- Structural Analysis-I
Course Outcomes	At the end of the course, the student will be able to
CO1	Analyze beams and portal frames using flexibility matrix method.
CO2	Analyze beams and portal frames using stiffness matrix method.
CO3	Analysis of arches, cables and suspension bridges
CO4	Plastic analysis of beams and portal frames

Detailed Syllabus:

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. **Plastic analysis of Structures**: Idealized stress - strain curve for mild steel; Moment - Curvature relationship for flexural members; Evaluation of fully plastic moment; Shape factor; Upper and lower bound theorems; Collapse load analysis of indeterminate beams and single bay, single storied portal frames.

Readings:

1. R L Jindal, "Indeterminate Structures", S. Chand & Co., New Delhi,
2. Wang C.K.- Intermediate Structural Analysis.
3. Reddy C.S.- Basic Structural Analysis - Tata Mc Graw- Hill Publishing Company Ltd.
4. G. S. Pandit -Structural Analysis: A Matrix Approach
5. V. N. Vazirani & M. M. Ratwani, Structural Analysis, Vol. II

CE 362	Construction Technology and Project Management	DEC	3-0-0	3 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the 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	Understand safety practices in construction industry
CO4	Prepare tender and contract document for a construction project
CO5	Identify the equipment used in construction

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 Contracts - Terminology used.
4. Equipment for construction - Earthwork - Concreting - Bitumen - Hoisting etc.,
5. Construction Finances – decision making,

Readings:

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.

SM355	Engineering Economics and Management	HSC	3-0-0	3 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions
CO2	Analyze cost/revenue data and carry out economic analyses in the decision-making process to justify existing/finding alternative projects on an economic basis
CO3	Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.
CO4	Apply models to describe economic phenomena; analyze and make predictions about the impact of government intervention and subsequent changing market conditions on consumer-producer relationship

Detailed Syllabus :

General Foundations of Economics: Forms of organizations-Objectives of firms-Opportunity Principle-Discounting-Production possibility frontier-Central problems of an economy- Two sector, Three sector, and Four sector circular flow of income-Demand analysis-Individual, Market and Firm demand- Determinants of demand and supply- Shifts and changes in demand and supply- Market equilibrium, Shortages versus surpluses- Elasticity of demand and business decision making

Production functions in the short and long run-Cost concepts- Short run and long run costs-economies and diseconomies of scale--Product markets- Market structure-Competitive market-Imperfect competition (Monopoly, Monopolistic competition and Oligopoly) Price discrimination-Game Theory--Maximin, Minimax, Saddle point, Nash Equilibrium, Prisoners' Dilemma- Monetary system-Indian stock market- Development Banks-NBFIs- role of Reserve Bank of India, Money Market, Capital market; NIFTY, SENSEX.

Brief introduction to data analytics as a tool in terms of understanding the markets, performances of indexes, performance of various sectoral indexes.

Introduction to Management Theory and Functional Areas-Marketing-HR and Finance-Financial Management-Financial Statements-Profit and Loss Statements-Fund Flow Statement-Balance Sheets-Ratio Analysis-Investment and Financial Decision—Inventory Management-Functions and Objectives of Inventory Management—Decision Models-Break even analysis-Economic Order Quantity (EOQ)-Model Sensitivity Analysis of EOQ model.

1. Reference:
2. K. E. Case, R. C. Fair and S. Oster, *Principles of Economics*. Prentice Hall, 10th ed., 2011.
3. Maheswari,Anil.*Data Analytics*.Mc Graw Hill, 2017
4. N. G. Mankiw, *Principles of Microeconomics*. Cengage Publications,7th ed.,2014.
5. P.A. Samuelson and W.D Nordhaus. *Economics*. Tata Mc graw Hill, 19th Ed., 2017.
6. R.S. Pindyck, D.L. Rubinfield and P.L. Mehta, *Microeconomics*, Pearson Education, 9th Edition, 2018.
7. R.W.Griffin, *Management, Principles and Practices*. Cengage India,11th ed.,2017.
8. S. B. Gupta. *Monetary Economics: Institutions, Theory & Policy*, New Delhi: S. Chand & Company Ltd., 2013.

Department of Civil Engineering

IVth Year Course Syllabus

CE401	Transportation Engineering – II	PCC	3-0-0	3 Credits
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to:			
CO1	Identify the factors governing the design of railway infrastructure			
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			
Detailed Syllabus:				

1. Introduction, Permanent Way and Components: History of Indian Railways; rail gauges, permanent way – functions, requirements, sections in embankment and cutting (single/double track), locomotives and other rolling stock, wheel and axle arrangement, coning of wheels, adzing of sleepers, Components – rails, sleepers, and ballast
2. Forces, Stresses, and Resistance of tracks: forces acting on rails, stresses in different components of track, types of resistances, tractive effort of a locomotive, hauling power of a locomotive
3. Geometric Design of Railway Track: horizontal alignment – horizontal curves, super-elevation, concepts of cant excess and deficiency, safe permissible speed, transition curves, vertical alignment – gradients and grade effects, string lining of curves.
4. Track Junctions and Signaling: turn outs, track junctions and layouts, objectives and classification of signaling, signaling systems, systems for controlling train movement, interlocking.
5. Railway Station and Yards: site selection for railways station and yards, facilities, classification of railways station, platforms, types of yards, equipment's at railway stations.
6. Introduction, Aircraft Characteristics, and Airport selection: Air transport development in India, national and international organizations in air transport, Aircraft and Airfield characteristics – 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, airport site selection, airport classification, passenger terminal system and its components, aircraft parking type, apron layout,.
7. Geometric and Structural Design of the Airfield Infrastructure: runway configurations, runway orientation, wind rose, estimating runway length; taxiway, exit taxiway geometry, location of exit taxiways, design of airfield pavements.

8. Navigational Aids and Lighting Systems: radio-based systems, radar systems; lighting systems – visual aids, marking and lighting of runway and apron area, wind and landing direction indicator, airfield signage.
Readings:
1. Satish Chandra and M. Agrawal, Railway Engineering. Second Edition, Oxford University Press, 2013.
2. Rangwala. Railway Engineering. Twenty Seventh Edition, Charotar Publishing House, Anand, India, 2017.
3. Mundrey, J. S. Railway Track Engineering, Fourth Edition, Tata McGraw-Hill Education Private Limites, New Delhi, 2010.
4. Hay, W. W. Railroad engineering. Vol. 1. John Wiley & Sons, 1982.
5. Rangwala. Airport Engineering. Seventeenth Edition, Charotar Publishing House, Anand, India, 2017.
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. Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. Planning and Design of Airports,
8. Fifth Edition, McGraw-Hill, New York, USA, 2010.

CE402	REMOTE SENSING IN CIVIL ENGG	PCC	3-0-0	3 Credits

Prerequisites	CE 204 Engineering Geology & Surveying

Course Outcomes	At the end of the course, the student will be able to:
CO1	Analyse the energy interactions in the atmosphere and earth surface features
CO2	To understand the characteristics of various platforms and concepts of image processing techniques for visual interpretation of satellite images
CO3	Apply the remote sensing techniques for various civil engineering problems

Detailed Syllabus:

1. Introduction to Remote Sensing: Sources of Energy, active and passive radiation, Electromagnetic spectrum, radiation laws, interaction of energy with atmosphere scattering, absorption, atmospheric windows, interaction of EMR with earth surface features- spectral signatures, stages in remote sensing. Sensors and Platforms: Orbital movement and Earth coverage. Sun-synchronous and Geosynchronous satellites, Active and passive sensors, Characteristics of satellites and sensors, LANDSAT, SPOT, NOAA and IRS Series. Fundamentals of Satellite Image Interpretation: Types of data products, visual interpretation techniques, basic concepts of digital image processing techniques.
2. Remote Sensing Applications in Civil Engineering - Landslide, Earthquake, Groundwater exploration, Hydro meteorological Hazards: Flash floods, River floods, Cyclones and Drought, Environmental hazards: Forest hazards (Deforestation, Degradation and Forest fire), and Pollution (Water, air and soil), Watershed Management, Environmental studies, Land use and Land Cover mapping – Urban sprawl and Transportation Network mapping, Geology and soil mapping, Ground Water Exploration.

Readings:

1. Floyd F. Sabins, Remote Sensing Principles and Interpretation, W.H. Freeman and Co. 2007.
2. Lillisand T.M and Kiefer R.W, Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.
3. Paul R. Wolf: Elements of Photogrammetry, with Air Photo Interpretation and Remote Sensing, McGraw Hill International Book Company, 2000.
4. Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall.

CE403	Design of Steel Structures	PCC	3-0-0	3 Credits

Prerequisites	CE201- Strength of Materials-I, CE251- Strength of Materials-II

Course Outcomes	At the end of the course, the 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 column splices and column base
CO5	Evaluate a steel structure for its safety using limit state design principles

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.

Readings:

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

CE404	Civil Engineering Software Laboratory	PCC	0-0-2	1 Credits

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to:
CO1	Write simple programs in MATLAB to carry out computer aided structural analysis.
CO2	To carry out computer aided analysis and design of multi storey buildings
CO3	Draw the detailing of different structural elements

Detailed Syllabus:

1. Stiffness Matrix Analysis of Beams by using MATLAB Programming Tool
2. Stiffness Matrix Analysis of Rigid Jointed Portal Frames by using MATLAB Programming Tool
3. Analyse and Design Reinforced Concrete Beam using software STAAD/ETABS
4. Analyse and Design Reinforced Rigid Jointed Portal Frame using software STAAD/ETABS
5. Analyse and Design a Multi Storey Building using software STAAD/ETABS

Readings:

1. Software manuals

CE 411	Prestressed Concrete	DEC	3-0-0	3 Credit

Prerequisites	CE303 - Design of concrete structures
Course Outcomes	At the end of the course, the 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

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.

Readings:

6. Krishna Raju. N “Prestressed Concrete”, Tata Mc Graw Hill.
7. Lin.T. Y,“Prestressed concrete”, Mc Graw Hill Pub. Co.
8. Rajagopalan, “Prestressed concrete”, Narosa Publishing House

CE 412	Introduction to Structural Dynamics	DEC	3-0-0	3 Credit
Prerequisites	CE201- Strength of Materials-I, CE251- Strength of Materials-II			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Understanding the elements of dynamic analysis			
CO2	Analyse Free vibration of the SDOF system			
CO3	Analyze Response SDOF system under harmonic loading			
CO4	Analyze Response SDOF system under general dynamics loading			

Detailed Syllabus:

1. Single Degree of Freedom Systems: Response under time-dependent Transient and Steady-state forcing functions – Damping effects – Greens function - Damping Vibrations system - response under general type of excitation – numerical methods-response spectrum.
2. Multi degree of Freedom Systems: Free vibration - Determination of Natural frequencies and mode shapes - Vanello Stodola and Matrix iteration methods – Energy Methods – Lagrange's equation – Simple applications.
3. Continuous Systems: Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods – Vibrating of building frames – modal analysis

Readings:

1. Structural Dynamics by Mario Paz.; CBS Publishers & Distributors, Delhi.
2. Dynamic of Structures by Rav W.Clough & Joseph Penzien; McGraw-Hill,
3. Dynamics of structures by A.K.Chopra

CE 413	Bridge Engineering	DEC	3-0-0	3 Credit

Prerequisites	CE303 – Design of concrete structures
Course Outcomes	At the end of the course, the student will be able to
CO1	Discuss the IRC standard live loads and design the deck slab type bridges.
CO2	Design of T-Beam bridges using various methods.
CO3	Design of sub structure parts of the bridge.
CO4	Design of various bridge foundations and discuss the different types of bridge bearings.

Detailed Syllabus :

1. Introduction & Investigation for Bridges Components of a Bridge; Classification; Need for Investigation; Selection of Bridge Site; Preliminary Data to be Collected; Preliminary Drawings; Determination of Design Discharge; Economical Span; Location of Piers and Abutments; Vertical clearance above HFL; Scour depth; Traffic Projection; Choice of Bridge type; Importance of Proper Investigation.
2. Standard specification for road bridges IRC Bridge code: width of carriageway: clearances: loads to be considered – dead load: IRC standard live loads: impact effect.
3. Design of Culverts: - Design of Reinforced concrete slab culvert.
4. Design of T – Beam Bridge
   Pigeaud‘s method for computation of slab moments; Courbon‘s method for computation of moments in girders; Design of simply supported T – beam bridge.
5. Sub Structure for Bridges- Pier and abutment caps; Materials for piers and abutments; Design of pier; Design of abutment; Backfill behind abutment.
6. Foundations for Bridges - Scour at abutments and piers; Grip length; Types of foundations; Design of well foundation.
7. Bearings for Bridges - Importance of bearings; Bearings for slab bridges; Bearings for girder bridges; Expansion bearings; Fixed bearings; Design of elastomeric pad bearing.

Readings:

1. Essentials of Bridge Engineering by Dr. Johnson Victor; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Design of Bridge Engineering by T.R Jagadeesh, M.A Jayaram, PHI Learning Pvt. Ltd,New Delhi
3. Bridge Engineering by Rangwala, Charotar Publishing House Pvt. Ltd.,
4. Design of Bridges by N. Krishna Raju, Publisher: Oxford & IBH Publishing Co Pvt. Ltd.
5. Bridge Engineering by S. Punnuswamy, (Third Edition 2017) Mcgrawhill Education Pvt.

CE 414	Quantity Surveying and Public Works	DEC	3-0-0	3 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. Estimate: Principles of estimation, units, items of work, different kinds of estimates, different methods of estimation, estimation of materials in single room building, two roomed building with different sections of walls for foundation, floors and roofs, R.B. and R.C.C. works, plastering, white-washing, distempering, painting, doors and windows, and lump sum items, estimates of canals and roads
2. Specification of Works: Necessity of specifications, types of specifications, general specifications, specification for bricks, cement, sand, water, lime, reinforcement; detailed specifications for earthwork, cement, concrete, brick work, floorings, D.P.C., R.C.C., cement plastering, white and colour washing, distempering, painting
3. Rate Analysis: Purpose, preparation of rate analysis, procedure of rate analysis for items:- earthwork, concrete works, R.C.C. works, reinforced brick work, plastering, painting, white-washing and distempering
4. Valuation: Gross income, net income, outgoings, scrap values, salvage value, obsolescence, annuity, sinking fund, depreciation, valuations of buildings.
5. Public Works Account: Regular and work charge establishment, earnest money, security money, retention money, muster roll, measurement book, cash book, examination and payment of bills, first and final bills, administrative sanction, technical sanction

Readings:

1. Chakraborti, M, Estimation, costing, specifications and valuation in civil engineering, National Halftone Co. Calcutta, 2005.
2. Dutta B.N., Estimation and costing in civil engineering: theory and practice UBS Publishers Distributors Ltd, 2006.
3. Central Public Works Department Schedule of rates

CE 415	Foundation Analysis and Design	DEC	3-0-0	3 Credit

Prerequisites	CE302 - Geotechnical Engineering–II
Course Outcomes	At the end of the course, the student will be able to
CO1	Understand the behavior of problematic soil
CO2	Design foundations on expansive soils
CO3	Analysis of shallow Foundation
CO4	Analyze the lateral stability of piles and wells

Detailed Syllabus:

1. Problematic and Expansive soils: different types of problematic soils, identification and characteristics of problematic soils, different types of expansive soils, identification and characteristics of expansive soils.
2. 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.
3. 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.
4. 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.

Readings:

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
6. Murthy V.N.S (2007): Soil Mechanics and Foundation Engineering – CBS publications, Delhi.

CE416	Ground Improvement Techniques	DEC	3-0-0	3 Credits
Prerequisites	CE204 - Engineering Geology & Surveying; CE302 - Geotechnical Engineering–II			
Course Outcomes	At the end of the course, the 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			
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

Readings:

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. Jie Han

Reference:

1. Han, J. – "Principles and practice of ground improvement", Wiley, 2015.
2. Kirsch, K. and Bell, A. – "Ground Improvement", CRC Press, 2013.
3. Koerner, R.M. – "Designing with geosynthetics", Pearson Education Inc., 2012.

CE417	Applications of Geosynthetics	DEC	3-0-0	3 Credits

Prerequisites	None

Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. Introduction: An overview on the development and applications various geosynthetics - the geotextiles, geogrids, geonets, geomembranes, geocomposites and natural Geosynthetics
2. Geosynthetics material properties**:** physical, mechanical, endurance, hydraulic, environmental properties.
3. Designing with geotextiles: Manufacture of geotextiles, Overview of various polymers used, – functions - Designing geotextiles for separation, reinforcement, stabilization, filtration and drainage.
4. Designing with geogrids: Manufacture of geogrids, Uniaxial and biaxial geogrids, – Designing for grid reinforcement in pavements, Retaining walls and bearing capacity.
5. Designing with geonets: Manufacture of geonets, -Designing geonet for drainage.
6. Designing with geomembranes: chemical properties and biological hazard - Applications for geomembranes.
7. Designing with geocomposites: Geocomposites in separation, 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.
8. Natural Geosynthetics - Types, properties and applications.

Readings:

1. Rao, G.V. and Goutam K. Pothal "Geosynthetics Testing – A laboratory Manual" Sai Master Environmental Services Pvt. Ltd. Hyderabad, 2008.
2. Sivakumar Babu G.L. "An Introduction to Soil Reinforcement and Geosynthetics" University Press, 2009.
3. Shukla, "An Introduction to Geosynthetics Engineering" CRC Press, 2017, Hyderabad

Reference:

1. Rao, G.V. – "Geosynthetics – an Introduction", Sai Master Geo environmental Services Pvt. Ltd. Hyderabad, 2011.
2. Koerner, R.M. – "Designing with geosynthetics", Pearson Education Inc., 2012.
3. Sarsby, R. W. – "Geosynthetics in Civil Engineering" –CRC., 2007

CE418	River Engineering	DEC	3-0-0	3 Credits

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to:
CO1	Understand the concepts of properties of sediments and regime of flow
CO2	Fundamental concepts bed and suspension load transport
CO3	Design of channels carrying sediment laden water

Detailed Syllabus:

1. Origin and properties of sediments: Nature of sediment problems, origin and formation of sediments, properties of sediments, incipient motion of sediment particles, tractive force approach, cohesive materials.
2. Regimes of flow: Description of regimes of flow, ripple, dune, antidune, prediction of regimes of flow. Resistance to flow and velocity distribution in alluvial streams, velocity distribution in turbulent flow over rough boundaries, resistance and velocity distribution in alluvial streams.
3. Bed load transport and saltation: Bed load equations, bed load equations based upon dimensional considerations and semi-theoretical equations, general comments on bed load equations, saltation.
4. Suspended load transport: Mechanism of suspension, equation of diffusion, sediment distribution equation, relations for suspended load, wash load, transport of suspended sediment.
5. Total load transport: sediment samplers design of canals carrying sediment laden water. Types of sediment samplers. Design of channels carrying sediment laden water. Sediment transport through pipes
6. Sediment Management Introduction; Erosion and sedimentation in drainage basins; Reservoir sedimentation process; Predictive methods for reservoir sedimentation; Mitigation of reservoir siltation; Reservoir sedimentation in India; Practices and Operational Difficulties -- Case studies.

Readings:

1. Garde R J and Ranga Raju K G, Mechanics of Sediment Transportation and Alluvial Stream Problems Wiley Eastern Ltd., 1985.
2. Yang C.T., Sediment Transport- Theory and Practice The McGraw Hill Companies Inc. 1996.
3. Chang H.H., Fluvial Processes in River Engineering John Wiley 1988.
4. Simons D.B. and Senturk F., Sediment Transport Technology, Water Resources Publications, Fort Collins, Colorado 1977
5. Handbook for Assessing and Managing Reservoir Sedimentation (CWC, February 2019).
6. Garde R J and Ranga Raju K G, Mechanics of Sediment Transportation and Alluvial Stream Problems Wiley Eastern Ltd., 1985.

CE419	Design of Hydraulic Structures	DEC	3-0-0	3 Credits

Prerequisites	CE 304 -Irrigation Engineering
Course Outcomes	At the end of the course, the student will be able to:
CO1	Understand the principles of design of hydraulic structures
CO2	Analyse and design of gravity dams
CO3	Analyse and design of earth and rockfill dams
CO4	Design of spillways and energy dissipation structures

Detailed Syllabus:

1. Introduction - Classification of dams, selection of site & type of dam, preparation and protection of foundation and abutments, dam safety and hazard mitigation

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.

3. Gravity Dams - Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam, Design of gravity dam, joints in gravity dam, Galleries in gravity dam, 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.

Readings:

1. Creager, W. P., Justin, J. D., and Hinds, J., "Engineering for dams", Nemchand and Brothers, Roorkee, 1995
2. Sharma, H.D., Concrete Dams, CBIP Publication, 1998
3. Siddiqui, I H, Dams and Reservoirs: Planning, Engineering, Oxford University Press, USA, 2009.
4. USBR, Design of gravity dams, A Water Resources Technical Publication, Denver, Colorado, 1976.
5. Novak, P., Moffat, A. I. B., Nalluri, C and Narayan, R., Hydraulic Structures, Taylor & Francis, 2006.

CE420	Watershed Management	DEC	3-0-0	3 Credits

Prerequisites	CE 255 - Engineering Hydrology.
Course Outcomes	At the end of the course, the 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

Detailed Syllabus:

1. Introduction - the 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.

Readings:

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.

CE421	Pavement Analysis and Design	DEC	3-0-0	3 Credits

Prerequisites	CE 351 - Transportation Engineering-I
Course Outcomes	At the end of the course, the student will be able to:
CO1	Comprehend the material specifications for the pavements.
CO2	Analyse stresses in flexible and rigid pavements
CO3	Design of flexible and rigid pavements
CO4	Design the overlay thickness for strengthening existing pavement.

Detailed Syllabus:

Types of pavements, Pavement composition, Philosophy of design of flexible and rigid pavements, Analysis of pavements using different analytical methods, Selection of pavement design input parameters, Traffic loading and volume, Material characterization, Drainage, Failure criteria, Reliability, Design of flexible and rigid pavements using different methods, design of overlays and drainage system.

Readings:

1. Huang, Y. H., Pavement Analysis and Design, Pearson Education.
2. Yoder, E. J. and Witczak, M. W., Principles of Pavement Design, John Wiley & Sons Ltd.
3. Mallick, R. B. and El-Korchi, T., Pavement Engineering: Principles and Practice, CRC Press.

CE422	Traffic Engineering and Design	DEC	3-0-0	3 Credits
Prerequisites	CE 351- Transportation Engineering-I			
Course Outcomes	At the end of the course, the student will be able to:			
CO1	Conduct traffic studies and estimate the basic characteristics of the traffic stream.			
CO2	Analyse the traffic data and interpret the results.			
CO3	Perform the capacity and level of service analysis for a road stretch.			
CO4	Analyse and design uncontrolled and signalized intersections with collected data.			
Detailed Syllabus:				
Human-vehicle-environment system, Fundamental parameters of traffic and relationships; Microscopic and macroscopic characteristics; Traffic data collection studies; Capacity and level of service analysis; Design of un-signalised and signalised intersections; Interchanges, Traffic signs. Traffic Signal design (Webster method, IRC method).				
Readings:				
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. B. Kent Lall, Transportation Engineering: An Introduction, Prentice Hall; 3rd Edition, 2003.				

CE423	Industrial Waste Treatment	DEC	3-0-0	3 Credits
Prerequisites	CE352 - 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			
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.				
Readings:				
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				

CE424	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			
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.
5. GIS to Identify Transport of Air Pollution in Urban Areas & Air Quality Monitoring, Modelling

Readings:

1. Colls, J., Air Pollution: Measurement, Modelling 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.

CE425	Environmental Modelling	DEC	3-0-0	3 Credits
Prerequisites	MA203 - 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			
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.

Readings:

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.

CE 461	Applied Stress Analysis	DEC	3-0-0	Credits: 3
Prerequisites	CE201 - Strength of Materials-I; MA203 - Mathematical Methods			
Course Outcomes	At the end of the course, the 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			
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 plane systems, 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.				
Readings:				
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				

CE 462	Repair And Rehabilitation of Structures	DEC	3-0-0	Credits: 3

Prerequisites	CE 254 – Building Materials & Concrete Technology, CE303-Design of Concrete Structures
Course Outcomes	At the end of the course, the 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	Formulate guidelines for repair management of deteriorated structures.

Detailed Syllabus:

1. Introduction: Present repair practices, distress identification and repair management - Causes of distress in concrete structures-Holistic Models for deterioration of concrete, Permeability of concrete, aggressive chemical agents, durability aspects
2. Condition Survey: Objectives, different stages-Preliminary inspection, planning stage, visual inspection, field laboratory testing stage, consideration for repair strategy
3. Non-Destructive Evaluation tests: Rebound hammer test-Ultrasonic pulse velocity tests, penetration resistance, pull out tests, core sampling and testing
4. Chemical tests: Carbonation tests and chloride content, Corrosion potential assessmentcover meter survey, half-cell potentiometer test, resistivity measurement – Case studies of RCC buildings subjected to distress-Identification and estimation of damage, structural integrity and soundness assessment, interpretation and evaluation of results
5. Selection of repair materials for concrete: Essential parameters for repair materials, Premixed cement concrete and mortars, polymer modified mortars and concrete, epoxy and epoxy systems, polyester resins, coatings
6. Repair methods: Guniting, shortcreting, polymer concrete system, reinforcement replacement, strengthening concrete by surface impregnation, polymer and epoxy overlays, Resin/polymer modified slurry injection, plate bonding technique, ferrocement jacketing, RCC jacketing, fiber wrap technique, chemical and electrochemical method of repair
7. Repair/Rehabilitation strategies: Stress reduction technique, repair and strengthening of columns and beams - Rehabilitation strategies, Propping and Supporting, Foundation Rehabilitation methods

Readings:

1. Concrete Structures-Repair, Rehabilitation and Retrofitting, B.Bhattacharjee, CRS Publishers and Distributors, 2017
2. CPWD Handbook on Repair and Rehabilitation of RCC buildings, Govt of India Press, New Delhi, 2014.
3. ACI 546R-14, Guide to Concrete Repair, American Concrete Institute, 2014

4. Concrete Structures-Protection, Repair and Rehabilitation, R.Dodge Woodson, Elsevier, 2009

CE 463	Design of Earthquake Resistant Structures	DEC	3-0-0	Credits: 3

Prerequisites	CE301 - Structural Analysis I and CE361- Structural Analysis II , CE412-Introduction to Structural Dynamics
Course Outcomes	At the end of the course, the 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

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.

Readings:

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.

CE 464	Introduction To Soil Dynamics	DEC	3-0-0	Credits: 3

Prerequisites	CE253-Geotechnical Engineering I
Course Outcomes	At the end of the course, the student will be able to
CO1	Apply theory of vibrations to solve dynamic soil problems
CO2	Calculate the dynamic properties of soils using laboratory and field tests
CO3	Field tests for determining the dynamic properties of the soil
CO4	Analyze liquefaction susceptibility of a site and determine factor of safety against liquefaction.

Detailed Syllabus:

- **Introduction**: Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics
- **Vibration theory**: Vibration of elementary systems; Degrees of freedom (SDOF and MDOF systems); Equation of motion for SDOF system; Types of vibrations, Critical damping; Decay of motion; Constant force and rotating mass oscillators; Dynamic magnification factor; Transmissibility ratio; Non-harmonic, arbitrary, impact and other types of forced vibrations; Duhamel's integral; Taxing of vehicles on uneven roads; Vibration isolation; Vibration measuring instruments; Equation of motion for MDOF system.
- **Wave Propagation**: Longitudinal and torsional waves in infinitely long rod; Solution for one-dimensional and three-dimensional equations of motion; Waves in semi-infinite body; Waves in layered medium; Earthquake waves – P-wave, S-wave, Rayleigh wave and Love wave; Locating earthquake's epicenter.
- **Dynamic Soil Properties**: Stresses in soil element; Determination of dynamic soil properties; Field tests; Laboratory tests; Model tests; Stress-strain behavior of cyclically loaded soils; Estimation of shear modulus; Modulus reduction curve; Damping ratio; Linear, equivalent-linear and non-linear models; Ranges and applications of dynamic soil tests; Cyclic plate load test; Liquefaction; Screening and estimation of liquefaction; Simplified procedure for liquefaction estimation; Factor of safety; Cyclic stress ratio; Cyclic resistance ratio; CRR correlations with SPT, CPT, SASW test values.

Readings:

7. Shamsher Prakash, "Soil Dynamics", McGraw-Hill Book Company.
8. Braja. M. Das, "Principles of Soil Dynamics", PWS-KENT Publishing Company.
9. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc.

Reference:

1. D. D. Barkan, "Dynamics of Bases and Foundations", McGraw-Hill Book Company.
2. E. E. Richart et al. "Vibrations of Soils and Foundations", Prentice Hall Inc.
3. Tien Hsing Wu, "Soil Dynamics", Allyn and Bacon Inc.

CE 465	Earthquake Geotechnical Engineering	DEC	3-0-0	Credits: 3

Prerequisites	CE302 - Geotechnical Engineering–II
Course Outcomes	At the end of the course, the 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

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. 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.
3. 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.
4. Slope stability analysis for earthquake: Introduction–inertia slope stability: pseudo static method, Newmark method–weakening slope stability: flow slides, liquefaction induced lateral spreading, strain softening soil–restrained retaining walls and temporary retaining walls– problems.

Readings:

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.

Reference:

1. B.M. Das and G.V. Ramana, “Principles of Soil Dynamics”, Cengage Learning, 2010.
2. IS-1893 (part-1) 2002,“Criteria for Earthquake resistant design of structures” part1 - general provision of buildings.
3. I. Towhata, “Geotechnical Earthquake Engineering”, Springer-Verlag Heidelberg, 2008.

CE 466	Geographical Information Systems	DEC	3-0-0	Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	Familiarize with concepts of choosing map projections, 2D transformation
CO2	Understand the fundamental data models and database preparation
CO3	Familiarize with concepts of geospatial analysis
CO4	Apply the GIS for various civil engineering problems

Detailed Syllabus:

1. Introduction – GIS definition, development, application areas. 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.
2. Fundamental concepts of GIS – Modelling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data, Database preparation and editing- Data collection and Input, Data conversion, Hardware & software Requirements, Topology – Editing and Error Rectification, Types of topology, Topological Relationships.
3. 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, Neighbourhood operations, DEM and TIN.
4. GIS Project Planning – Steps in GIS project, Problem Identification and Implementation of a GIS project. GIS Applications – Transportation, Water Resources, Environment, Geology, Agriculture, Urban planning, climate change.

Readings:

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.

CE 467	Climatology & Climate Change	DEC	3-0-0	Credits: 3

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Understand the Earth's atmospheric system and evaluate the current state of climate change science.
CO2	Identify the key factors affecting the local and global climate at different times.
CO3	Understand various climate models and their development to assess the impacts of climate change.
CO4	Understand the development of future climate change scenarios.

Detailed Syllabus:

1. Introduction, Course overview, Structure and Composition of the Atmosphere, Components of the climate system.
2. Global energy balance and Radiative transfer in the atmosphere, global climate models, Climate sensitivity to changes in greenhouse gases and feedback mechanisms between the components.
3. Brief history of climate: causes and mechanisms, Internal climate variability, The climate since the Earth's formation, The last million years: glacial interglacial cycles.
4. Future climate changes: Emission scenarios, the purpose of the scenarios and scenario development, Special Report on Emission Scenarios (SRES), Representative concentration pathways (RCPs), Climate projections for the 21st century.
5. Changes in global mean surface temperature, The spatial distribution of surface temperature and precipitation changes, Changes in the ocean and sea ice, Changes in the carbon cycle and climate-carbon feedbacks, Long-term climate changes, The carbon cycle. - Impact on urban Flooding & Design Considerations for Smart Cities

Readings:

1. Introduction to Atmospheric Chemistry, by Daniel J. Jacob, Princeton University Press, (2004)
2. First principles of meteorology and air pollution by Mihalis Lazaridis (2010). Springer.
3. Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre, and V. Zunz (2010). Introduction to climate dynamics and climate modelling.

CE 468	Road Safety Engineering	DEC	3-0-0	Credits: 3

Prerequisites	CE351-Transportation Engineering-I

Course Outcomes	At the end of the course, the student will be able to
CO1	Identify the road safety issues.
CO2	List out the factors contributing to the accident.
CO3	Collect, analyze, and manage accident data.
CO4	Perform the investigation and diagnosis of the accident.

Detailed Syllabus:

- Introduction to Road Safety Engineering: Road safety scenario, Road safety issues, Characteristics of road accidents, Factors contributing to road accidents; Accident data analysis and Management; Road safety measures: Road alignments, Road sign and pavements markings, Street lighting and traffic signal, Pedestrian facilities; Crash Investigation and analysis: Human/vehicular factor relating to crashes, Steps of crash investigation, Diagnosing the crash problem, Solutions/accident costing/economic appraisal; Road Safety Audit (RSA): Introduction to RSA, Feasibility stage audit, Design stage road safety audit, Construction stage audit, Pre and post opening stage audit, Audit report, Site visit to for road safety audit.

Texts:

1. Road Safety: Data Collection, Analysis, Monitoring, And Countermeasure Evaluations with Cases by M. Ohidul Haque, University Press of America, 2008.
2. The Handbook of Road Safety Measures by Rune Elvik, Alena Hoye, Truls Vaa, Emerald Group Publishing, 2nd Edition, Sept 2009.
3. Practical Road Safety Auditing by M. Belcher, Steve Proctor, P. Cook, Thomas Telford Publishing, 2008.
4. IRC: SP: 88-2019 Manual on Road Safety Audit.
5. Traffic Engineering by R. P. Roess, E. S. Prassa, W. R. Mcshane, Prentice Hall, 2011.
6. Transport Planning and Traffic Engineering by CA O'Flaherty, Elsevier, 2006.

CE 469	Environmental Impact Assessment	DEC	3-0-0	Credits: 3

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

Detailed Syllabus:

Evolution of EIA EIA at project Regional and policy levels Strategic EIA EIA process Screening and scoping criteria Rapid and comprehensive EIA Specialized areas like environmental health impact assessment Environmental risk analysis Economic valuation methods Cost-benefit analysis Expert system and GIS applications Uncertainties. Legislative and environmental clearance procedures in India and other countries, Siting criteria CRZ Public participation Resettlement and rehabilitation. Practical applications of EIA EIA methodologies Baseline data collection Prediction and assessment of impacts on physical, biological and socio-economic environment Environmental management plan Post project monitoring, EIA report and EIS Review process. Case studies on project, regional and sectoral EIA. 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.

Readings:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. A Chadwick, Introduction to Environmental Impact Assessment, Taylor & Francis , 2007
3. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002
4. Larry W. Canter, Environmental Impact Assessment, McGraw Hill Inc. Singapore , 1996
5. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.

CE 470	Solid Waste Management	DEC	3-0-0	Credits: 3

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	Analyse 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

Detailed Syllabus:

Sources and types of municipal solid waste – Waste generation rates – Factors affecting generation, composition, characteristics - Methods of sampling – Effects of improper disposal of solid wastes – Public health and environmental effects. Elements of solid waste management – Municipal solid waste rules – Source reduction of waste – Reduction, Reuse and Recycling – Segregation of wastes at source – Onsite storage methods – Materials used for containers – Case studies under Indian conditions. Methods of collection of municipal solid wastes – Collection vehicles – Manpower – Collection routes – Analysis of collection systems – Need for transfer and transport – Transfer stations – Selection of location, operation & maintenance. Objectives of waste processing – Processing technologies – Biological and chemical conversion technologies – Resource recovery from solid waste composting and biomethanation – Thermal processing options. Land disposal of solid waste – Sanitary landfills – Site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas – Landfill closure and environmental monitoring – Landfill bioreactor – Dumpsite rehabilitation -Case Studies - Wealth from waste and entrepreneurs in India and other countries

Readings:

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. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.
5. Qian X, Koerner RM and Gray DH, ‘Geotechnical Aspects of Landfill Design and Construction’ Prentice Hall, 2002.

CE 471	Introduction To Life Cycle Analysis	DEC	3-0-0	Credits: 3

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Thorough understanding of the concepts of sustainability and the challenges that engineers face in applying these concepts in an industrial and societal context.
CO2	Detail training on how to use LCA.
CO3	Critically analyse environmental emissions and develop simple methodologies to reduce these emissions.

Detailed Syllabus:

- An Introduction to Sustainability Concepts and Life Cycle Analysis - Risk and Life Cycle Framework for Sustainability - Environmental Data Collection and LCA Methodology (Overview - Goal Definition, LCI, LCIA, LCI, LCA Software tools) - Life Cycle Assessment – Detailed Methodology and ISO Framework - Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, Interpretation of LCIA Results) Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Fate and Transport) - Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis) - Case Studies

Readings:

1. Introduction to Sustainability for Engineers, 1st Edition, Toolseeram Ramjeawon, 2020, ISBN 9780367254452, CRC Press
2. Environmental Life Cycle Assessment, Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz, 2015, CRC Press
3. Circular Economy and Sustainability, Volume 1: Management and Policy, Editors: Alexandros Stefanakis, Ioannis Nikolaou, eBook ISBN: 9780128203965

Department of Civil Engineering

Open Elective Course Syllabus

CE340	REPAIR AND REHABILITATION OF INFRASTRUCTURE	OPC	3-0-0	3 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Assess the health of aging infrastructure			
CO2	Use of Non-Destructive Testing techniques for health assessment			
CO3	Suggest materials and techniques for repairing and rehabilitation of deteriorated concrete structures			
CO4	Apply cost effective retrofitting strategies for repairs in buildings			
Detailed Syllabus:				
1. Aging and performance of infrastructure, consequences – need for rehabilitation. 2. Distress in concrete– damage – source – cause – effects – case studies. 3. Damage assessment and Evaluation models – Damage testing methods – NDT – Core samples. 4. Rehabilitation methods – case studies. 5. Methods of repairs – shortcreting – guniting – epoxy – cement mortar injection – crack ceiling.				
Readings:				
1. Diagnosis and treatment of Structures in Distress – R N Raikar, R & D Centre, Structwel Designers & Consultants, 1994.				
2. Building Failures – Diagnosis and Avoidance – W H Ranson, E. & F.N. Spon, 1981				
3. Forensic Engineering – Kennethe and Carper, CRC Press, 2000				

CE390	INFRASTRUCTE FOR SMART CITIES	OPC	3-0-0	3 Credit

Prerequisites	None
Course Outcomes	At the end of the course, the student will be able to
CO1	Acquaint knowledge on smart cities planning and development
CO2	Develop work break down structure, scheduling and project management of smart cities
CO3	Work out the most energy efficient technique

Detailed Syllabus:

1. **Fundamental of smart city & Infrastructure:** Introduction of Smart City, Concept of smart city, Objective, History of Smart city world and India. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems
2. **Planning and development of Smart city Infrastructure**: Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security, Project management.
3. **Intelligent transport systems:** Smart vehicles and fuels, GIS, GPS, Navigation system, traffic safety management, Internet of Things (IoT)
4. **Management of water resources and related infrastructure:** Storage and conveyance system of water, sustainable water and sanitation, sewerage system, flood management, conservation system
5. **Infrastructure Management system & Policy for Smart city**: Integrated infrastructure management systems for smart city, Infrastructure management system applications for existing smart city. Worldwide policies for smart city Government of India - policy for smart city, Mission statement & guidelines, Smart cities in India, Case studies of smart city.

Readings:

1. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend
2. Beyond Smart Cities: How Cities Network, Learn and Innovate, Tim Campbell, ISBN: 978-1-84971-426-6
3. Grig N.S., Infrastructure engineering and management, Wiley-Interseience, 1988
4. Hudson W.R., Haas R., Uddin W., Infrastructure Management, McGraw-Hill, 1997
5. Mission statement &guidelines on Smart City Scheme. Government of India - Ministry of Urban Development

CE490	DISASTER MANAGEMENT	OPC	3-0-0	3 Credit

Prerequisites	None

Course Outcomes	At the end of the course, the student will be able to
CO1	To impart knowledge about the disaster Management
CO2	To introduce the fundamental concepts relevant to various aspect of disaster
CO3	To enable the students to understand the factors that causes the disaster

Detailed Syllabus:

1. **Understanding Disasters:** Understanding the Concepts & definitions of Disaster, Hazard, Vulnerability, Risk, Capacity–Disaster, Development & management, Types, Trends, Causes, Consequences and Control of Disasters: Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters
2. **Disaster Management Cycle and Framework:** Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment
3. **Disaster Management in India:** Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter Governmental Agencies
4. **Applications of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System

Readings:

1. Disaster Management by W. Nick. Carter, 1991: Asian Development Bank, Manila
2. Introduction to International Disaster Management by D. P. Coppola, 2007, Elsevier Science (B/H), London.
3. Manual on natural disaster management in India by M C Gupta, NIDM, New Delhi

Department of Civil Engineering

Minor Course Syllabus

Modalities for the award of B.Tech. Degree with Minor in particular specialization are as follows:

a. A student will be eligible to receive minor degree when he/she takes at least 6 additional courses (4 Theory and 2 Lab courses) constituting 16 credits between III to VII semesters.
b. The minor degree courses will be over and above the minimum B. Tech. credit requirements (162 credits).
c. Every department will prepare a list of courses to be offered for minor degree under each specialization
d. Selection of students for Minor degree program will be on merit basis as per CGPA at the completion of I B.Tech. (2 semesters).
e. Students with a minimum CGPA of 7.5 (with no backlog courses) shall be eligible for minor degree program selection process.
f. It is mandatory for all the departments to offer courses for minor degree specialization.
g. The CGPA of minor degree will be reflected separately in the same grade sheet.

Minor Degree Offered by Department of Civil Engineering:

Minor in Geoinformatics: Course Structure							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Offered SEM**
01	CEM251	Unmanned Aerial Systems	4	0	0	4	IV
02	CEM301	Principles of Remote Sensing	4	0	0	4	V
03	CEM351	Digital Image Processing	4	0	0	4	VI
04	CEM401	Fundamentals of GIS	4	0	0	4	VII

Minor in Environmental Sustainability: Course Structure							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Offered SEM**
01	CEM261	Sustainability for Engineers	4	0	0	4	IV
02	CEM311	Basics of Life Cycle Analysis	4	0	0	4	V
03	CEM361	Environmental Impact Assessment	4	0	0	4	VI
04	CEM411	Basics of Climate Change	4	0	0	4	VII
05	CEM412	Integrated Solid Waste Management	4	0	0	4	VII

GEOINFORMATICS

CEM251	Unmanned Aerial Systems	OEC	4-0-0	4 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Understand the capabilities and limitations of the UAS			
CO2	Understand the fundamental concepts of selecting the right UAS and its performance			
CO3	Understand the rules and regulations governing operating a UAS in India			
CO4	Know the current UAS activities in GIS and mapping			
Detailed Syllabus:				
Introduction to the Unmanned Aerial System: UAS History, UAS System Overview, UAS Status Classification of the Unmanned Aerial Systems, Missions of the UAVs, Summary and Final Tasks UAS mission planning and control; Aviation Regulatory and Certificate of Authorization (COA) Process: Guidelines and Certificate of Authorization (COA); Products Generation: The Photogrammetric Process, Imagery Geo-location, Ground Control Requirement, Products Generation; UAS Safety and Privacy Concerns: Privacy Concerns & Safety and Security Concerns; Current UAS Activity in GIS: Agriculture, Emergency services, Geospatial services, AOI mapping through UAV: Topographical mapping, Hydraulic mapping, Identification Unauthorized construction, Storm water analysis using Stream Network and DTM, Utility Mapping, New Road Network designing				
Readings:				
1. Barnhart, R., Michael, M., Marshall, D., and Shappee, E. ed. 2016. Introduction to Unmanned Aircraft Systems, 2nd edition. Boca Raton. CRC Press. ISBN 978-1482263930.				
2. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley & Sons Ltd. ISBN: 9781119978664..				
3. Wolf, P., DeWitt, B., and Wilkinson, B. 2014. Elements of Photogrammetry with Applications in GIS, 4th edition. McGraw-Hill. ISBN: 978-0071761116				

CEM301	PRINCIPLES OF REMOTE SENSING	OEC	4-0-0	4 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Analyse energy interaction with atmosphere and earth surface feature			
CO2	Understand the satellite and sensor characteristics, and Image interpretation keys			
CO3	Understand the properties and use of different satellite data and their specifications			
CO4	Discuss broad application areas of remote sensing technology			
Detailed Syllabus:				
Basic Concepts: History and Principles; Electromagnetic, Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance; Interaction of EMR with Atmosphere and Earth's Surface; Spectral Signatures; Characteristics of Satellite Sensor; Remote Sensing Sensors; Scanning System; Sensor & Satellite Characteristics; Image interpretation keys; Characteristic of optical detectors; imaging sensors, Thermal sensors; Atmospheric sensors; Sonar; Laser, radar, hyperspectral sensors. Data Acquisition Platform: Balloon, Rocket, Helicopter, Aircraft and Spacecraft, Applications: Monitoring and management of resources, Sustainable development, Disaster mitigation, Natural hazards, Weather & Communication Satellites.				
Readings:				
1. James B. Campbell & Randolph H. Wynne., Introduction to Remote Sensing, The Guilford Press, 2011..				
2. Charles Elach & Jakob van Zyl., Introduction to the physics and techniques of Remote Sensing, John Wiley & Sons publications, 2006				
3. Lillesand T.M & Kiefer R.W., Remote Sensing and Image Interpretation, John Wiely and Sons, 2008.				
4. Christian Matzler., Thermal microwave radiation: Applications for remote sensing, The institution of Engineering and Technology, London, 2006.				
5. Rees, W. G., Physical principles of Remote Sensing, Cambridge University Press, 2001				

CEM351	DIGITAL IMAGE PROCESSING	OEC	4-0-0	4 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Understand the different data formats and corrections for remote sensing data			
CO2	Provide the knowledge on image pre-processing corrections			
CO3	Gain knowledge on different enhancement techniques			
CO4	Apply the enhancement classification techniques using software			
Detailed Syllabus:				
Introduction to digital image processing- concept of digital image; Image formats; Image registration; Radiometric & geometric correction of remotely sensed data; Pre-processing of remote sensing data; Atmospheric Correction Methods; Illuminations and View Angle Effects, Sensor Calibration and Terrain Effects and radiometric correction methods; Image enhancement techniques-Contrast enhancement - linear and nonlinear, histogram equalisation and density slicing, Spatial filtering and edge enhancement, Multi image manipulation – addition, subtraction and band rationing; Image classification techniques using AI and ML				
Readings:				
1. John R Jensen, Introductory Digital Image Processing, Prentice Hall, New Jersey,2004..				
2. Robert G Reeves, Manual of Remote Sensing Vol. I & II, American Society of Photogrammetry, Falls Church, USA, 1983				
3. Florence Tupin, Jordi Inglada and Jean-Marie Nicolas, Remote Sensing Imagery, ISTE and Wiley, 2014.				
4. Nello Cristiani and John Shawe Taylor., An Introduction to Support Vector Machines, Cambridge University Press, 2000				

CEM401	FUNDAMENTALS OF GIS	OEC	4-0-0	4 Credit
Prerequisites	None			
Course Outcomes	At the end of the course, the student will be able to			
CO1	Gain knowledge on concepts of map, map projection and geospatial data models			
CO2	Understand the concept of database management systems & data structures in GIS			
CO3	Understand the concepts of spatial data analysis and GIS project planning			
CO4	Expose the engineering applications in Open-source GIS platform			
Detailed Syllabus:				
1. Basics of Geographic Information System (GIS): Definition, components, packages, capabilities and purpose of GIS. Concept of maps, map-features, scale, projection, Geographical coordinate system, Types of projection. Geospatial Data Models: Spatial and non-spatial. GIS Databases: Types of Databases; Data Structures: Raster and Vector Structures, Spatial Data Analysis – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Map composition, Preparation of qualitative and quantitative maps, levels of maps, map elements and map scales, GIS Project Planning and Implementation, GIS Applications in various field: Agriculture, Disaster Management, Mapping and Navigation, Urban and town planning. 2. Open-Source GIS lab: Overview of QGIS or later: Overview of Attribute Data Input: Importing maps and layers from various sources, Georeferencing and projection, Digitization of Points and Lines, Editing Map Elements, Attribute Data Entry and Manipulation Cleaning, Data Analysis – Overlay, Buffer, Map Generation with Patterns and Legends, image classification techniques				
Readings:				
1. Paul Longley., Geographic Information systems and Science, John Wiley & Sons, 2005				
2. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.				
3. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008				
4. Burrough, P.A., Principles of GIS for Land Resource Assessment, Oxford Publications, 2005.				
5. C.P.Lo & Albert K. W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt.Ltd, 2002				

ENVIRONMENTAL SUSTAINABILITY

CEM261	SUSTAINABILITY FOR ENGINEERS		4-0-0	4 Credit
Detailed Syllabus:				
An Introduction to Sustainability - Sustainable Development and Role of Engineers- Sustainable Engineering: Concepts, Principles, and Frameworks - Tools for Sustainability Assessment - Fundamentals of Environmental Impact Assessment, Life Cycle Assessment, Risk Assessment - Integrating Sustainability in Engineering Design -Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis) - Case Studies				
Readings:				
1. Introduction to Sustainability for Engineers by Toolseeram Ramjeawon CRC Press				
2. Sustainable Environmental Engineering by Walter Z. Tang, Mika Sillanpää, Wiley				

CEM311	BASICS OF LIFE CYCLE ANALYSIS		4-0-0	4 Credit
Detailed Syllabus:				
An Introduction to Sustainability Concepts and Life Cycle Analysis - Risk and Life Cycle Framework for Sustainability - Environmental Data Collection and LCA Methodology (Overview - Goal Definition, LCI, LCIA, LCI, LCA Software tools) - Life Cycle Assessment – Detailed Methodology and ISO Framework - Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, Interpretation of LCIA Results) Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Fate and Transport) - Case Studies				
Readings:				
1. Practicing Circular Economy by Prasad Modak, CRC Press				
2. Introduction to Sustainability for Engineers by Toolseeram Ramjeawon CRC Press				

CEM361	ENVIRONMENTAL IMPACT ASSESSMENT		4-0-0	4 Credit

Detailed Syllabus:

Introduction to Environmental impact assessment (EIA) - Evolution of EIA - Sustainable development - Generalised EIA process flow chart - Environment Risk assessment, Pollution prevention and Waste minimization, sustainable development (SD), Life cycle assessment. Global Environmental Issues - EIA - Screening and scoping criteria - Rapid and comprehensive EIA - Impact assessment methods - Legislative and environmental clearance procedures - Practical applications of EIA - EIA methodologies, Baseline data collection, Prediction and assessment of impacts on physical, biological and socio-economic environment - Environmental management plan, - Post project monitoring, initial environmental examination (IEE), environmental impact statement (EIS), environmental appraisal, environmental audit (EA), Environmental impact factors and areas of consideration, measurement of environmental impact, organisation, scope and methodologies of EIA, case studies stressing physical aspects of environment, EIA at project, Regional and policy levels.

Readings:

1. Wathern P., "Environmental Impact Assessment: Theory and Practice", Routledge Publishers,1990
2. Marriott B., "Environmental Impact Assessment: A Practical Guide", McGraw-Hill Publication,1997
3. Shrivastava A.K., Baxter Nicola, Grimm Jacob, "Environmental Impact Assessment", APH Publishers, 2003
4. Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011
5. Glasson J., Therivel Riki, Chadwick Andrew, "Introduction to Environmental Impact Assessment", Oxford Brookes University 2012/ 4th edition
6. Wathern P., "Environmental Impact Assessment: Theory and Practice", Routledge Publishers,1990

CEM411	BASICS OF CLIMATE CHANGE		4-0-0	4 Credit
Detailed Syllabus:				
Introduction – Basic Terminology – Intergovernmental Panel on Climate Change (IPCC) – Role of IPCC in Understanding the Climate Change– General Circulation of Atmosphere – General Circulation of Ocean. Earth's Atmosphere – Weather and Climate – Some Definitions – The Earth's Climate Machine - Global Wind Systems – Trade winds and the Hadley Cell – The Highs and Lows of the Westerlies – Monsoon Rains and their Importance. Global Circulation – Clouds and Cloud Formation – Storms and Climate - Global Ocean Circulation – El Niño and La Nina Phenomenon – Effects of El Nino and La Nina – El Niño the Southern Oscillation – Other Global Circulations. General Circulation Models (GCMs) – Merits and Limitations of GCMs – Large-scale and Local-scale variables – Importance of Downscaling – Over view of Downscaling Techniques – Computer Applications in Modelling the Climate. Climate Change Impacts on Engineering Systems – Case Studies – Role of Engineers in developing the Mitigation/Adaptation Strategies				
Readings:				
1. Subrahmanya, K., 2008, Engineering Hydrology, Tata Mc Graw Hill Pub. Co., New Delhi.				
2. Ojha CSP, R. Berndstsson and P Bhunya (2008), Engineering Hydrology, Oxford University Press Co., New Delhi.				
3. F M White, Fluid Mechanics, Tata McGraw Hill Publication 2011.				
4. Murthy, C. S. N., 2002, Water Resources Engineering – Principles and Practice, New Age International Publishing Company, New Delhi.				

CEM412	INTEGRATED SOLID WASTE MANAGEMENT		4-0-0	4 Credit
Detailed Syllabus:				
Introduction to Solid Waste Management (SWM) - Municipal Solid Waste (MSW) Characteristics and Quantities- MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program - MSW Collection, Transportation, Segregation and Processing - Disposal of MSW - Landfill - Biochemical Processes and Composting- Energy Recovery from MSW - Current Issues in SWM and Review of MSW Management Status in First List of 20 Smart Cities in the Country - Construction and Demolition (C&D) Waste Management – Overview - C&D Waste Regulation, Beneficial Reuse of C&D Waste Materials - Electronic Waste (E-Waste) Management Issues and Status in India and Globally -E-Waste Management Rules 2016 and Management Challenges				
Readings:				
1. Integrated Solid Waste Management: Engineering Book by George Tchobanoglous, Hilary Theisen, and S. A. Vigil, McGraw Hill Education				
2. Integrated Solid Waste Management: A Life Cycle Inventory, 2nd Edition Forbes R. McDougall, Peter R. White, Marina Franke, Peter Hindle, Wiley				
3. Integrated Solid Waste Management: Engineering Book by George Tchobanoglous, Hilary Theisen, and S. A. Vigil, McGraw Hill Education				

Department of Civil Engineering

Honors Course Syllabus

Modalities for the award of B.Tech. Degree with Honors in the same discipline are as follows:

a. A student will be eligible to receive Honors degree when he/she takes at least 20 credits between V to VII semesters (3 or 4 credit courses).
b. A maximum of 6 credits (out of 20 credits) can be studied in MOOCS (3 or 4 credit courses).
c. All the courses to be taken in Honors degree stream including the MOOCS courses should be duly approved by respective BoS committees.
d. The honors degree courses will be over and above the minimum B. Tech. credit requirements (162 credits).
e. Every department will prepare a list of courses to be offered for honors degree
f. Selection of students for Honors degree program will be on merit basis as per CGPA at the completion of II B.Tech. (4 semesters).
g. Students with a minimum CGPA of 7.5 (with no backlog courses) shall be eligible for honors degree program selection process.
h. The CGPA of honors degree will be reflected separately in the same grade sheet

Honors Degree Offered by Department of Civil Engineering:

S. No.	Course Code	Course Name	L	T	P	C	Category Code
01	CEH301	Theory of Plates and Introduction to Shell	4	0	0	4	PCC
02	CEH302	Groundwater Hydrology	4	0	0	4	PCC
03	CEH351	Environmental Geotechnics	4	0	0	4	PCC
04	CEH352	River Hydraulics and Sediment Transport	4	0	0	4	PCC
05	CEH401	Biological Treatment of Wastewater	4	0	0	4	PCC
06	CEH402	Advanced Surveying Techniques	4	0	0	4	PCC

CEH301	Theory of Plates and Introduction to Shell	PCC	4-0-0	4 Credits

Prerequisites	Strength of Material I (CE 201) & II (CE 251)
Course Outcomes	At the end of the course, the student will be able to:
CO1	To introduce the concept of plate theory and study the behavior and analysis of thin plates
CO2	To study the procedure for rectangular plates and circular plates subjected to lateral loads
CO3	To learn about folded plate analysis and the stability of thin plates in normal and shear stresses
CO4	To introduce the different types of shells and common first order theories like membrane theory and bending theory
CO5	To gain a basic introduction to advanced concepts of Foppl-von Karman plate theory, thick-plate theory, higher order shell theories, DKJ theory etc

Detailed Syllabus:

1. Thin plates with small deflection; assumptions - Long plates in cylindrical bending, strain energy in rectangular plates - governing differential equations (Kirchhoff Plate) and various boundary conditions
2. Simply supported rectangular plates - Navier solution with various types of loads, rectangular plates with various boundary conditions - Naviers method for patch/point loads - Levy's method, Axi-symmetric circular plates
3. Demonstration of numerical methods – Finite difference method and Kantorovich method - Approximate analysis of Grids– Analysis of Folded Plates by Winter-Pei distribution
4. Overview on Orthotropic plates – Overview on Large deflection of plates and midplane stretching (Foppl - von Karman plate) – Overview on Mindlin Reissner Theory - Stability of rectangular plates fundamentals - some edge conditions- design applications such as section classification and simple postcritical method
5. Shells: structural behavior, classification, translational and rotational shells- hyperbolic paraboloid- elliptic paraboloid- Gaussian curvature - Overviews on Shell theories such as Higher order theories, Marguerre theory, DKJ Theory etc - Membrane theory of shells- cylindrical shells- shells of revolution including design

Readings:

1. Szilard, R., Theory and Analysis of Plates -Classical and Numerical Methods, Prentice Hall Inc., 2004
2. Timoshenko, S.P. and Krieger S.W., Theory of Plates and Shells, McGraw Hill Book Company, NewYork, 2003
3. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Company, 1981

CEH302	Groundwater Hydrology	PCC	4-0-0	4 Credits

Prerequisites	Fluid Mechanics (CE 202) , Open Channel Hydraulics (CE 252)
Course Outcomes	At the end of the course, the student will be able to:

CO1	To know different types of aquifers
CO2	To understand the surface and subsurface investigation in detail
CO3	To integrate the fundamental and basic knowledge of ground water movement
CO4	To understand the process of sea water intrusion and recharge
CO5	To introduce the different model studies

Detailed Syllabus:

1. Groundwater occurrence – distribution – aquifer – types - Surface investigation - Geophysical - electrical resistivity - Seismic refraction - Gravity and magnetic - Geologic - Air photo interpretation - Dowsing.
2. Subsurface investigation - test drilling - resistivity logging- potential logging - temperature and caliper logging.
3. Steady unidirectional flow - well in a uniform flow - steady flow with uniform recharge unsteady radial flow to a well - well flow near aquifer boundaries - Multiple well systems - partially penetrating wells - characteristic well losses.
4. Secular and seasonal variations - Fluctuations due to evapo-transpiration, Meteorological phenomena, tides, external loads and earthquakes - control by drains and wells. Recharge through sewage pits, shafts and wells.
5. Occurrence of sea water intrusion - Ghypon-Heizberg relation between fresh and saline waters - shape length and structure of the fresh salt water interface -prevention and control of seawater intrusion - role of sea water in ground water - coastal zoning.
6. Sand models - Electrical models - Viscous fluid models - membrane models - numerical analysis methods

Readings:

1. Raghunath H.M., Ground Water Hydrology, New-Age International, 2nd Edition, 1990
2. Todd, D.K, Ground Water Hydrology, Prentice hall, 2004

CEH351	Environmental Geotechnics	PCC	4-0-0	4 Credits

Prerequisites	Geotechnical Engineering- I (CE 253) & II (CE 302)
Course Outcomes	At the end of the course, the student will be able to:
CO1	Consider the possible susceptibility of soil properties to Environmental effects
CO2	Identify contaminant transport mechanisms in soils
CO3	Estimate environmental influences on engineering properties of soil to be used in the design
CO4	Apply environmental changes to soil stabilization and landfill engineering

Detailed Syllabus:

1. Introduction: Soil-the three-phase system, Clay - the most active soil fraction, Clay-water interactions, Causes of soil deterioration, Scope and importance of environmental geo-techniques
2. Ground Contamination: Sources of contamination, chemical diffusion in soils, practical range of flow parameters, simultaneous flow of water, current and salts through a soil, Electro kinetic phenomenon, coupled influences on chemical flow, chemical compatibility and hydraulic conductivity
3. Classification of Soil and Susceptibility to Environment: Susceptibility to the environment, mineralogy, formation and isomorphism substitution, Factors affecting surface activity of soils, Ion-exchange and its mechanics, Theories of ion-exchange, clay-organic interactions, Atomic absorption spectroscopy analysis, Mechanisms controlling the index properties of fine-grained soils
4. Engineering Properties of Soil due to Changing Environment: Engineering properties and environment, Permeability and its mechanisms, volume change behaviour, Basic mechanisms controlling compressibility, Quasi pre-compression, compression behaviour of saturated Kaolinitic and Montmorillonitic clays with different pore fluids, shear strength Behaviour of Kaolinitic and Montmorillonitic clays with different pore fluids, components of shear strength and their mechanisms
5. Soil Modification by Environmental Changes: Stabilisation of soil by environmental changes, use of additives and their basic mechanisms, effect of lime on sulphate bearing clays, effect of phosphoric acid, use of fly ash in soil modification, use of hydroxy-aluminium in clay stabilization, stabilization by chemical transport
6. Waste Containment: Overview on landfill liners, Siting considerations and geometry, typical cross-sections, grading and leachate removal, case studies

Readings:

1. Abdel-Mohsen Onsy Mohamed, Evan K. Paleologos, Devendra Narain Singh and Valeria Guimarães “Fundamentals of Geoenvironmental Engineering: Understanding Soil, Water, and Pollutant Interaction and Transport”, Elsevier Science, 2017, 0128048301, 9780128048306.
2. A. Sridharan, “Engineering Behaviour of Fine-Grained Soils” A Fundamental Approach, IGS Annual Lecture – 1991.

3. J. K. Mitchell, “Fundamentals of Soil Behaviour” John Wiley & Sons, Inc. New York, 1993.
4. T. S. R. Ayyar, “Soil Engineering in Relation to Environment” Published by LBS Centre for Science and Technology, Thiruvananthapuram, 2000.

Reference:

1. R. M. Koerner, “Designing with geosynthetics”, Pearson Education Inc., 2005.
2. D. E. David, and R. M. Koerner, “Waste Containment Facilities” ASCE Press, Allied Pub. Pvt. Ltd., 2007.

CEH352	River Hydraulics and Sediment Transport	PCC	4-0-0	4 Credits

Prerequisites	Engineering Hydrology (CE 255) and Irrigation Engineering (CE 304)

Course Outcomes	At the end of the course, the student will be able to:
CO1	To understand the behaviour free surface flow conditions under varying depths of flow in open channel
CO2	To understand the process of the steady, unsteady and gradually varying flow in rivers and open channels
CO3	To Illustrate the design methods of cross section of channels for different flow and geometry conditions.
CO4	To Provide idea on flow computation, velocity distribution in a river or artificial channel with complex geometry, plan form and flow conditions (steady and unsteady)
CO5	To understand the Sediment generation and transportation behaviours in Rivers and channels

Detailed Syllabus:

1. Derivation of the general one-dimensional equations of continuity, momentum and energy used in open channel flow analysis. Steady non-uniform flows, channel transitions and controls, hydraulic jumps surges-Surface profile for gradually varied flow.
2. Unsteady flow in open channels, method of characteristics, surge formation. Kinematics of waves, flood routing and overhead flow, Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Spatially varying flow and rapidly varying flow.
3. River Engineering: Classification of Rivers, Causes of Meandering, The Aggrading type of River, Stage-discharge curves for meandering channels Degrading type of River, Cutoffs, river Training, Types of Training Works.
4. Origin and formation of sediments- properties of sediments, lift force, tractive stress concept on cohesion less and cohesive soils. Velocity of flow of sediments, regimes of flow; Resistance to flow in alluvial streams, resistance relations based on total resistance and division of resistance into grain and form resistance.
5. Velocity distribution in alluvial channel, Scouring, Bed load computation by empirical equations, dimensional considerations and semi-theoretical equations, siltation, Mechanism of suspension, general equations of diffusion

Readings:

1. V. T. Chow, Open Channel Hydraulics, McGraw-Hill Publishing Company, New Delhi, 1993
2. Rajesh Srivastava, Flow through open channels, Oxford University Press, 2008.
3. M. Hanif Chaudhry, Open-Channel Flow, Springer, USA, 2nd edition, 2008
4. K. Subramanya, Flow in Open Channel, Tata McGraw, 2009.

CEH401	Biological Treatment of Wastewater	PCC	4-0-0	4 Credits
Prerequisites	Environmental Engineering- I (CE 203) & II (CE 352)			
Course Outcomes	At the end of the course, the student will be able to:			
CO1	To learn the fundamentals of process kinetics and bioreactors			
CO2	To study about various biological treatment processes and its operations for the wastewater treatment.			
CO3	To provide knowledge about the kinetics of biological growth and its application in the design of biological reactors			
CO4	To explain the design principles and operational problems involved in various biological treatment processes			

Detailed Syllabus:

Constituents of wastewaters-Sources-Fundamentals of Process Kinetics- Enzyme reactions. Bioreactors- types, Classification, design principles. Design of wastewater treatment systems-Primary, secondary and tertiary treatments- Evaluation of Biokinetic Parameters - Activated Sludge and its process- types- Biological Nitrification and denitrification. Attached Growth Biological Treatment Systems- Trickling Filters Rotating Biological Contactors. Waste stabilization ponds and Lagoons: Aerobic Pond, facultative pond, anaerobic ponds-polishing ponds, aerated Lagoons. Anaerobic processes-Process Fundamentals-Standard, high rate and hybrid reactors, Anaerobic Filters-Expanded /fluidized bed reactors-Up flow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors- Sludge Digestion, Sludge disposal

Readings:

1. Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982
2. Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980
3. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.

CEH402	Advanced Surveying Techniques	PCC	4-0-0	4 Credits

Prerequisites	Engineering Geology & Surveying (CE 204)

Course Outcomes	At the end of the course, the student will be able to:
CO1	To know the significance of advanced surveying in field measurements in terms of utility and precision of data collection
CO2	To learn the principles of Electromagnetic distance measurement, Total Station and their accuracy
CO3	To get introduced to the concept of photogrammetry in preliminary identification and map making
CO4	To know in detail the concept of remote sensing in identification of land features from space and to get introduced to different data acquisition techniques like LIDAR, RADAR etc
CO5	To get introduced to the field of geodesy, coordinate systems, Map projections, GPS, its working principle, data collection, data processing and analysis

Detailed Syllabus:

1. Electromagnetic distance measurement (EDM) – Principle of EDM Carrier waves – Types of EDM instruments – Distomat – Total Station – Principle – procedure & surveying using Total Station – precise levelling - micro-optic theodolite.
2. Photogrammetry – Terrestrial and Aerial Photogrammetry – Horizontal position of a point from photographic measurement – elevation of a point – Determination of focal length of camera – determination of scale – Ground co-ordinates - Relief displacement – Photo interpretation.
3. Remote sensing – concepts – Idealized remote sensing system – characteristics – Types of remote sensing system – Remote sensing from space – Data interpretation – application of remote sensing – LIDAR – RADAR - SONAR.
4. Geodesy – Figure of earth – Classification – Earth surface - Geodetic reference surfaces - Coordinate systems – Geodetic datums and elements – Map – Scale of map – projection – UTM – Map projection of India – Space Geodesy
5. GPS Basics – system overview – working principle of GPS – Satellite ranging – calculating position – Ranging errors and its correction – GPS surveying Methods – static, Rapid static, DGPS and Kinematic methods – visibility diagram – GAGAN - GNSS

Readings:

1. Duggal, S.K. Surveying Vol. II, Tata McGraw Hill, 2004
2. Punmia, B.C. Surveying Vol.III, Standard Publishers, 2005
3. Arora, K. R. Surveying Vol. III, Standard Book House, 1996
4. Satheesh Gopi. Advanced Surveying, Pearson Education, 2007.
5. Satheesh Gopi. The Global Positioning System and Surveying using GPS, Tata McGraw, 2005.

Open Elective Syllabus

BT341	ENVIRONMENTAL TECHNOLOGY	OPC	3–0–0	3 Credits

Prerequisites: None

Course Outcomes:

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

CO1	Understand the importance of water quality and treatment of wastewater
CO2	Understand the types of solid waste and their management
CO3	Understand the fundamental aspects of air pollution and its control
CO4	Apply biological methods for remediation of contaminated soil

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	-	2	3	1	-	-	1	2	3	-	-
CO2	2	2	3	1	-	2	3	1	-	-	1	2	3	-	-
CO3	2	2	3	1	-	2	3	1	-	-	1	2	3	-	-
CO4	3	3	3	1	-	2	3	-	-	-	1	2	3	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Unit I

Introduction of environmental technology. water and wastewater: Water quality and control – Sources of water pollution, Water quality standards for potable water, Health effects of water pollutants, Fundamentals of water treatment process; wastewater characterization, Fundamentals of wastewater treatment (primary, secondary and tertiary treatment).

Unit II

Solid and hazardous Waste Management: Municipal Solid waste management **-** Sources and classification. Management and methods of processing of waste. Hazardous waste management – sources, classification, treatment and disposal methods. Plastic waste – sources and types, management practices. Microplastics and its impact on environment.

Unit III

Air pollution and control: Sources, classification and health effects, Air quality standards, control of air pollution. Techniques for air pollution control - cyclones, wet dust scrubbers and fabric filters for particulate matter, gas absorption, Biological control of gaseous pollutants.

Unit IV

Bioremediation of contaminated sites: Introduction, engineering strategies of bioremediation: site characterization, *in situ* and *ex situ* strategies. Phytoremediation – introduction and mechanisms of phytoremediation.

Text Books:

1. Garg, S. K. (1999). *Water supply engineering – environmental engineering (Vol.I)*. Khanna Publishers.
2. Metcalf & Eddy, Inc. (2003). *Waste water engineering treatment and reuse* (4th ed.). McGraw Hill Education.
3. Masters, G. M., & Ela, W. P. (2007). *Introduction to Environmental Engineering and Science* (3rd ed.), Pearson Education.
4. Rittmann, B. E., & McCarty P. L. (2003). *Environmental biotechnology: principles and applications* (1st ed.). Tata McGraw-Hill Education.
5. Hale, R. C., Seeley, M. E., La Guardia, M. J., Mai, L., & Zeng, E. Y. (2020). A global perspective on microplastics. *Journal of Geophysical Research: Oceans*, *125*(1), e2018JC014719.

CH340	Paper Production 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	Explain process for manufacturing paper
CO2	Identify harmful impacts of paper and pulp industries on environment.
CO3	Describe mechanical-chemical pulping processes
CO4	Distinguish methods for pulp treatment.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	3	-	-	-	-	-	1	3	1
CO2	1	3	-	-	2	-	3	-	-	-	-	-	1	3	1
CO3	1	3	-	-	-	-	3	-	-	-	-	-	1	3	1
CO4	1	3	-	-	2	-	3	-	-	-	-	-	1	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Detailed Syllabus:

Introduction and Paper Making Raw Materials: History of Paper Making, Paper Making Raw Materials: Wood Anatomy and Chemistry, Wood Chip Preparation and Handling at The Pulp Mill, Solid Wood Measurement, Properties of Selected Wood Species.

Pulping Processes and Pulp Treatment: Introduction to Pulping, Mechanical Pulping, Chemical Pulping, Semi-Chemical Pulping, Soda Pulping, Kraft Pulping, Sulfite Pulping, Other Pulping Methods, Bleaching Mechanical Pulps, Measurement of Lignin Content, Bleaching Chemical Pulps, Chemical Recovery, Refining, Pulp Characterization.

Paper Making Equipment and Process: Fiber Preparation and Approach, Raw Materials, Functional Additives, Control Additives, Wet End Chemistry, Paper Manufacture, Paper Machine, Headbox, Fourdrinier Wet End, Twin Wire Formers, Cylinder Machine, Press Section, Dryer Section, Post Drying Operations, Coating.

Environmental Protection: Water Pollution, Water Quality Tests, Aqueous Effluent Treatments, Air Pollution, Air Quality Tests and Control, Solid Waste Disposal.

Properties of Paper: General Grades of Paper, Structure, Mechanical and Chemical Properties, Basic Optical Tests of Paper.

Readings:

1. J. P. Casey, Pulp and Paper: Chemistry and Chemical Technology, Volumes 1 & 2, Wiley
   Inter science, 3rd Edition, 1980.
2. G. A. Smook, Handbook for Pulp and Paper Technologists, Angus Wilde Publ, Inc, 3rd Edition, 2002.
3. Christopher J. Biermann, Handbook of Pulping and Paper Making, Academic Press, 1996.
4. Monika EK, Goran Gellerstedt, Gunnar Henrikson, Pulping Chemistry and Technology, Walter De Gruyter & Co, 2009.
5. George T. Austin, Shreve's Chemical Process Industries, McGraw Hill Education, 5th Edition, 2017.

CE340	REPAIR AND REHABILITATION OF INFRASTRUCTURE	OPC	3-0-0	3 Credit

(This course is not offered to Civil Engineering Students)

Prerequisites None

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

CO1	Assess the health of aging infrastructure
CO2	Use of Non-Destructive Testing techniques for health assessment
CO3	Suggest materials and techniques for repairing and rehabilitation of deteriorated concrete structures
CO4	Apply cost effective retrofitting strategies for repairs in buildings

Detailed Syllabus:

6. Aging and performance of infrastructure, consequences – need for rehabilitation.
7. Distress in concrete– damage – source – cause – effects – case studies.
8. Damage assessment and Evaluation models – Damage testing methods – NDT – Core samples.
9. Rehabilitation methods – case studies.
10. Methods of repairs – shortcreting – guniting – epoxy – cement mortar injection – crack ceiling.

Readings:

4. Diagnosis and treatment of Structures in Distress – R N Raikar, R & D Centre, Structwel Designers & Consultants, 1994.
5. Building Failures – Diagnosis and Avoidance – W H Ranson, E. & F.N. Spon, 1981
6. Forensic Engineering – Kennethe and Carper, CRC Press, 2000

CS340	Object Oriented Programming	OPC	3– 0 – 0	3 Credits

Pre-requisites:

i. Introduction to Algorithmic Thinking and Programming (CS101)

ii. Introduction to Algorithmic Thinking and Programming Lab (CS102)

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

CO1	Construct programs using Object Oriented Design principles like abstraction, polymorphism and inheritance and typing. (Apply)
CO2	Develop applications with handlers for user-defined exceptions, according to the given requirements. (Apply)
CO3	Develop efficient multi-threaded applications with synchronization constructs. (Apply)
CO4	Develop interactive GUI applications with event handling to provide rich user experience. (Apply)
CO5	Develop applications that use file input and output. (Apply)

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M		L				L			L
CO2	S	M	M	L	L				L			L
CO3	S	M	M	L	L				L			L
CO4	S	M	M	L	M				L			L
CO5	S	M	M	L	M				L			L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Overview of Object-Oriented Programming and its need, Java Programming Elements: Classes and Objects, Data types, Constructors, Input-Output Handling, Control

structures, Method overloading and overriding, Abstraction and Inheritance, Interfaces, final and static: classes, blocks and methods, Packages.

Exception Handling: Types of Exceptions, Exception classes, try, catch, throw, throws and finally, Exception Handling with Method Overriding, Custom Exceptions.

Multithreaded Programming: Introduction to multitasking through processes and threads, The Java Thread Model, creating threads, thread life cycle, thread scheduling, thread priorities, daemon thread, synchronization.

Garbage Collection, Runtime class and Memory management in Java.

String handling: String, StringBuffer, StringBuilder and tokenizer.

Generics: The Collections framework: List, Set and Map interfaces, Enumerator.

Event handling: Event, Listeners and adapter classes, anonymous inner classes.

Abstract Windowing Toolkit (AWT): Button, Label, Checkbox, CheckboxGroup, TextField, TextArea, Choice, List, Menu, Panel, Scrollbar and Layout managers.

File I/O: Character based Streams, Readers and Writers, RandomAccess, Scanner.

Reading List:

1. Java: The Complete Reference, Herbert Schildt, 11th edition, Mc Graw Hill, 2019.
2. Head First Java, Kathy Sierra & Bert Bates, 3rd edition, O'Reilly, 2005.
3. Clean Code, Robert C Martin, Pearson, 2012.
4. Object Oriented Programming with Java, Timothy Budd, Updated Edition, Pearson Education, 2020.
5. Object Oriented Programming with Java, Debasis Samanta, IIT Kharagpur, accessed through: https://cse.iitkgp.ac.in/~dsamanta/java/index.htm, Accessed on: August 2021.

EE340	Introduction to Renewable Energy Systems	OPC	3-0-0	3 Credits

Pre-requisites: EE101- Elements of Electrical Engineering
Course Outcomes: At the end of the course the student will able to:

CO1	Understand the need and applications of renewable energy systems
CO2	Understand the types and latest developments in renewable energy systems
CO3	Analyze the energy conversion process in solar and wind energy generating systems
CO4	Analyze the energy conversion process in bio and ocean energy generating systems
CO5	Analyze the energy conversion process in fuel cell and geothermal energy generating systems

Detailed Syllabus:

Renewable Energy Capacity Statistics across India and Global
Fossil fuel energy usage, climate change and global warming, role of renewable energy in sustainable development, Introduction to renewable energy systems, types of renewable energy systems, differences between renewable energy systems and Conventional energy systems, potential and current installation of renewable energy systems across India and Global.

Solar Photovoltaic Systems
Introduction to Solar Photovoltaic Cell, solar panels, History of PV development and deployment, the solar resource: Spectra, insolation, diffuse vs. direct, atmospheric absorption, metrics for specifying system output, land area requirements, MPPT.

Wind Energy Systems
Introduction, Principle of wind energy conversion, types of wind energy systems, Advantages and disadvantages of wind mills, Applications of wind energy.

Bio-Energy Systems
Energy from biomass, Sources of biomass, Different species, Conversion of biomass into fuels, Energy through fermentation, Pyrolysis, gasification and combustion Biogas plants, Properties and characteristics of biogas.

Ocean Energy Systems
Introduction, Principle of ocean thermal energy conversion (OTEC), Tidal power generation, Tidal energy technologies, Energy from waves, Wave energy conversion, Wave energy technologies, advantages and disadvantages.

Other Renewable Energy Systems Introduction to Fuel Cell and Geothermal energy systems, working principle, advantages and disadvantages, latest developments in fuel cell and Geothermal energy systems.

References:

1. Edward S. Cassedy, Peter Z. Grossman “Introduction to Energy: Resources, Technology, and Society” Cambridge University Press, 1998
2. Charles R. Russell “Elements of Energy Conversion” Elsevier, 2013
3. Archie W. Culp “Principles of energy conversion” McGraw-Hill, 1979
4. Fang Lin Luo, Ye Hong “Renewable Energy Systems: Advanced Conversion Technologies and Applications” CRC Press, 2012

EC340	Communication Systems	OPC	3-0-0	3 Credits

Course Outcomes: After the completion of the course the 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 trade-offs and performance of communications systems.

Course Articulation Matrix:

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	-	S	M	-	-	-	-	-	S
CO2	-	S	-	-	S	M	-	-	M	-	-	S
CO3	M	-	-	-	S	-	-	-	-	-	-	S
CO4	-	-	-	-	-	S	-	-	M	L	-	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

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.

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.

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.

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.

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.

Text books:

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

ME340	AUTOMOTIVE MECHANICS	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil

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, electricalsystem, and ignition system.
CO3	Understand fuel supply systems in a 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	3	3	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Detailed syllabus:

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulationsystems, Components of water-cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto, and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fueland oil filters, pressure, and dry sump systems.

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

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch**-** Single and multi-plate 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.

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.

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.

ME341	NEW VENTURE CREATION	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil

Course Outcomes: At the end of the course, the 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 framework.
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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:

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small-Scale Enterprise: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE: Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws. **Performance appraisal and growth strategies:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. Bruce R Barringer and R Duane Ireland, "Entrepreneurship: Successfully Launching New Ventures", 3rd Edition, Pearson Education, 2013.
2. D.F. Kuratko and T.V. Rao, "Entrepreneurship: A South-Asian Perspective", CengageLearning, 2013.
3. Dr. S.S. Khanka, "Entrepreneurial Development", 4th Edition, S Chand & Company Ltd.,2012.
4. Dr. Vasant Desai, "Management of Small-Scale Enterprises", Himalaya Publishing House,2004.

MM340	Introduction to Materials Science and Engineering	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, ceramics, polymers, composites
CO2	Explain different fabrication techniques of materials
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select suitable materials for desired applications

Course Articulation Matrix:

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	S	-	M	-	-	-	-	-	-	-	-	-	M	-	L	L
CO2	S	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CO3	S	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L
CO4	M	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Syllabus:

CLASSES OF MATERIALS:

Metals and alloys, oxide and non-oxide ceramics, polymers, and composites, Materials Paradigm – relation between processing, structure, properties, and applications of materials

STRUCTURE OF MATERIALS:

Atomic structure and interatomic bonding, Different levels of structure in materials, Polycrystalline, amorphous, and single crystalline materials; Partial crystallinity, Texture or crystallographic orientation of materials, Isotropy and anisotropy, Crystal structure of

metals, alloys, and ceramics; Polymer structures, Crystal defects and imperfections in materials, Phase diagrams, Allotropy, Polymorphism, Polytypism.

PROPERTIES OF MATERIALS:

Thermal properties: Heat capacity, Thermal expansion, Thermal conductivity, Thermal stresses

Mechanical properties: Elastic and plastic deformation, stress, strain, tension, compression, shear force, hardness, rigidity, strength, ductility, malleability, fatigue, creep, fracture and failure of materials

Optical properties: Reflection, Refraction, Absorption, Transmission, Opacity and Translucency Luminescence, Photoconductivity

Electrical properties: electrical conduction and resistance, semiconductivity, dielectric behavior

Magnetic properties: magnetism, types of magnetism, magnetic moment, magnetic dipoles, magnetic field strength, magnetic induction, magnetization, permeability, susceptibility

APPLICATIONS OF MATERIALS:

Structural, functional, and biomedical applications

Text Books:

1. W.J. Callister, Materials Science and Engineering: An Introduction, Wiley, 2010
2. W.F.Smith, Foundations of Materials Science and Engineering, Tata McGraw Hill, 2008
3. D.R. Askeland, Essentials of Materials Science and Engineering, Cengage, 2013
4. J.F. Shackelford, Introduction to Materials Science for Engineers, Pearson, 2015
5. V Raghavan, Materials Science and Engineering – A first course, PHI Publications, 2011

HS340	Soft Skills	OPC	3 – 0 – 0	3 Credits

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

CO1	Enhance communication skills
CO2	Develop team building and leadership skills
CO3	Adapt to diverse cultural contexts
CO4	Apply appropriate etiquette in various contexts

Detailed syllabus

Definition and significance of soft skills-soft skill and Johari window-personality-types of personality-personality development-elements of personality development--process of communication-personal SWOT analysis- purpose of communication - key elements of communication-characteristics of effective communication-avoiding miscommunications-7Cs of communication

Common mistakes to avoid-cross-cultural communication-Indianisms-wrong usage of English.-social and personal conversation-social media communication-arguments-discussion and talks. dealing with conflicts- overcoming communication barriers-importance of interpersonal relationships-types of interpersonal relationships-uses of interpersonal relationship skills-factors affecting inter-personal relationships-accommodating different styles-importance of workplace relationships

Verbal communication -listening skills-speaking skills-importance of non-verbal communication-types of non-verbal communication-silence-space -kinesics -self-image management- first impression-types of first impression-factors that affect one's

self image-developing personal brand-correlation between self-esteem and self-image- building self-esteem and confidence-managing social media image

Group vs team-Team building-stages in team development-becoming part of winning team-teamwork: an essential element of professionalism-ways to resolve conflict-negotiation skills- understanding behaviour-comfort zones-assertiveness-characteristics of high-performance teams

Definition and significance of leadership-qualities of a good leader -functions and responsibilities of leadership-styles of leadership- skills required for time management to avoid procrastination- goal setting-hard work vs smart work- -setting achievable and smart goals-professional-personal balance-recognizing and tackling stress related issues-common signs of stress- professional work attitude

Diversity in workplace- gender-race-disability-age-cultural awareness-cultural intelligence-cultural competency- benefits of diversity—new ideas-higher productivity-improved customer service-reputation-self-evaluation--personal responsibility-positive attitude-conscientiousness-resourcefulness—flexibility-rapport building-loyalty-good work habits-decision making-respect for context

Resume writing and job application-practical resume writing tips-cv, resume and biodata-cover letter- importance of interview-checklist for interview preparation-types of interviews- interview questions -presentation skills-importance of professional appearance- Writing etiquettes-letters-e-mails-thank you notes -applying online-applying in person-personal etiquette-travel etiquette-using office utilities and resources

References:

Alex, K.Soft Skills: *Know Yourself and Know the World*.S.Chand& Co.2013.

Harrison, Lucy*. Soft skills for Tough Jobs*. Practical Inspiration Publishing,2022.

Mether,Leah:*Soft is the New Hard.How to Communicate Effectively Under Pressure*. Methmac Communications Pvt. Ltd.2019.

Murty, G.R.K.*Soft Skills for Success*:Viva Books.2016

Rao, M.S. *Softskills: Enhancing Employability:Connecting Campus with Corporate*. IK International Publishing House, 2010

Sharma, Prashant. Soft Skills: *Personality Development for Life Success*.2 Edition.BPB Publication, 2020.

Singh,B.D*. Managing Conflict and Negotiation.* Excel Books.2008

SM340	Corporate Communication for Engineers	OPC	3 – 0 – 0	3 Credits

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

CO1	Understand the significance of corporate communication and corporate reputation management and the relevance of corporate communication in brand promotions
CO2	Enhance employee communication and manage governmental relations
CO3	Evaluate financial communication and Corporate Social Responsibility
CO4	Manage crises and understand corporate laws

Detailed syllabus

Definitions of corporate communication-evolution of corporate communication-roots of corporate communication in India-various communication kinds-placement of corporate communication within the organization-corporate communication functions-trinity in corporate communication-corporate governance-reputation@Net Age-rating research-image repair theory-corporate reputation management imperatives-Building Corporate Image-corporate advertising- brand image insensitivity-consumer pr-innovative strategies in reaching out to customers-third-party advantage through media endorsements-area of discord-sponsorships-online sponsorships-brand promotion events

Definition of employee communication-genesis of employee communication-corporate communication and its interface with other management functions-outsourcing internal communication-theoretical underpinning in employee communication-theories that impact employee communication-segmenting internal publics-media for internal communication-business and government: symbiotic relationship-industry associations and their role in government relations-public affairs/lobbying-issue management-crisis communication

Evolution of financial communication in India-financial institutions in India-working of various financial institutions-capital market-various financial instruments in the capital

market-mutual funds-fraudulent practices: Impact on investors wealth-definition of crisis-measures to bridge the gap between government sources and media during and after a natural disaster

Definition of CSR-Genesis of CSR-Theoretical underpinnings of CSR-Various phases of CSR in India-Global

practices of CSR-Provisions in the companies act 2013-corporate philanthropy

Theoretical underpinnings in corporate communication research-informal research techniques-formal research methods-campaigns/programme evaluation-image surveys/studies-communication audit-dashboard and score cards-media research-web research-desk research-mass media laws- defamation law-invasion of privacy-the copyright act-digital piracy-RTI act 2005-various corporate laws-The press council of India

References:

Argenti, Paul A .*Corporate Communication*. 6th edition. McGrawhill.2013

Belasen.Alan T. *The Theory and Practice of Corporate Communication:A Competing Values Perspective*. Sage, 2007.

Jethwaney, Jaishri. *Corporate Communication:Principles and Practice*. Sage, 2018.

Nirbhay Lumde. *Corporate Social Responsibility in India:A Practioner's Perspective.* Notion Press, 2018.

Van Riel, Cees B.M. and Charles J Fombrun. *Essentials of Corporate Communication: Implementing Practices for Effective Reputation Management*. Routledge, 2007

HS344 (Odd Sem) **HS394 (Even Sem)**	**Spanish**	**OPC**	**3 – 0 – 0**	**3 Credits**

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

CO1	Introduce oneself and set up an essential dialogue in the target language.
CO2	Communicate using the basic grammar and vocabulary levels in the target language.
CO3	Comprehend the culture and society of the target language's country through simple texts, songs, films, and photos.
CO4	Create sentences and paragraphs on various topics with significant precision and in detail.
CO5	Demonstrate comprehension of the spoken/written language in translating simple sentences.
CO6	Create and enhance the autonomy of the language.

Detailed syllabus

Module:1 Abecedario; Saludos y Despedidas

Antecedentes sobre el idioma español, Breve historia hispánica, El Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Números Cardinales (1-100)

Recursos Gramaticales: Vocales y Consonantes, Sílabas. Artículos definidos e indefinidos (Número y Género).

Recursos Comunicativos: Saludar y despedirse: Aprender a Presentarnos, a preguntar cosas en clase.

Module:2 Datos personales; recursos para preguntar sobre las palabras

Edad y posesión, Números Cardinales (101-100 000), Profesión, Los días de la semana.

Recursos Gramaticales: Pronombres personales. Adjetivos. Los verbos SER y TENER. Los verbos regulares (-AR, -ER, -IR) en el presente.

Recursos Comunicativos: Escribe sobre mismo/a y los compañeros de la clase.

Module:3 Describir lugares; Expresar existencia y ubicación

Hacer un conocimiento del mundo Hispano, Vocabulario de Mi habitación, Países y Ciudades. Colores, Números Ordinales: Del Primero a Décimo (1 - 10). Descripción de lugares y cosas.

Recursos Gramaticales: Adjetivos posesivos. El uso del verbo SER y ESTAR. Diferencia entre SER y ESTAR. ¿qué, cuál / cuáles, cuántos / cuántas, dónde, cómo, quién, cuándo?

Recursos Comunicativos: Mi habitación, Mi Ciudad.

Module:4 Mi familia; Direcciones; Expresar la hora y los gustos

Mi familia. Direcciones. Expresar la hora.

Los meses del año. Expresar y preguntar sobre gustos e intereses.

Recursos Gramaticales: Frases preposicionales. Uso del HAY.

La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR, JUGAR, También. Los verbos regulares (-AR, -ER, -IR) en el presente.

Recursos Comunicativos: Mi familia. Dar opiniones sobre tiempo.

Module:5 El clima; habilidades y aptitudes; Cualidades y defectos de las personas

Expresar fechas, el tiempo y las direcciones. Presentar y Describir a una persona y lugar.

Recursos Gramaticales: Los verbos irregulares (E-IE, O-UE, E-I) en el presente.

Recursos Comunicativos: Mi mejor amigo/a. Expresar fechas. Traducción Inglés al español y español al inglés.

Module:6 Describir el diario; Las actividades cotidianas;

Describir el diario. Las actividades cotidianas. Identificar objetos, expresar necesidad.

Recursos Gramaticales: Los Verbos y pronombres reflexivos y posesivos. Traducción Inglés a español y español a inglés.

Recursos Comunicativos: El horario.

Module:7 La Gastronomía: Ir al Restaurante

La Gastronomía: ¡A Comer! Dar opiniones sobre alimentos y bebidas.

Decir lo que está haciendo. Describir mi ciudad y Ubicar los sitios en la ciudad.

Recursos Gramaticales: Los verbos irregulares. Estar + gerundio.

Poder + Infinitivo.

Recursos Comunicativos: En la cafetería, Conversación en un restaurante. Traducción Inglés al español y español al inglés. Mi ciudad natal. Mi Universidad. La clase. Mi fiesta favorita. Tiempo libre.

Text Book:

Elena Verdia, Marisa Gonzalez, Felipe Martin, Inmaculada Molina, Conchi Rodrigo, Nitzia Tudela, January 2016, En Acción Curso de Español, Langers Inter national Pvt Ltd, New Delhi, India

Reference Books:

Shalu Chopra, VIVA LATINO 1, January 2019, Goyal Publishers and Distributors Pvt. Ltd, New Delhi, India

Ramón Díez Galán, Nuevo DELE A1: Versión 2020. Preparación para el examen. Modelos de examen

DELE A1 (Spanish Edition), July 14, 2020, Independently Published. Spain.

Charo Cuadrad, Pilar Melero, Enrique Sacristan, PROTAGONISTAS A1. LIBRO DEL ALUMNO,1 January 2018, Goyal Publishers and Distributors Pvt. L td, New Delhi, India

HS345 (Odd Sem) HS395 (Even Sem)	French	OPC	3 – 0 – 0	3 Credits

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

CO1	Introduce oneself and frame simple sentences in the target language.
CO2	Understand the basic grammar and use of vocabulary in an appropriate way.
CO3	Perceive the culture and society of the country in various aspects.
CO4	Create sentences and paragraphs on various topics.
CO5	Demonstrate comprehension of the spoken / written language in translating simple sentences.

Detailed Syllabus

Module:1 Les alphabets, les salutations, se presenter, presenter quelqu'un.

Les salutations, les pays et les nationalités, les nombres, les couleurs.

Grammaire : La conjugaison des verbes réguliers (-er), être, avoir, s'appeler, savoir, les pays, les adjectifs de nationalité, les articles définis, les couleurs, L'usage des pronoms sujets, le masculin et le féminin du nom (genre), le pluriel des noms, l'usage de « c'est / il est/ elle est », le verbe « avoir/ savoir », les adjectifs réguliers/ irréguliers, les prépositions de lieu/ transport, l'article indéfini, les nombres 1-50 **Savoir – faire :** saluer, se présenter, demander et donner des informations sur soi-même/ sur quelqu'un, créer une carte de visite, Décrire les personnages / les objets,comprendre un texte simple.

Module:2 Les nombres, demander et donner des informations

Commander, questionner, expliquer

Grammaire : Les verbes « aller, venir », pouvoir, prendre,trouvez la question, reliez la phrase donnée, les articles contractés, l'adjectif interrogatif, les nombres 50-100, Répondez aux questions, formulez des questions avec « qu'est-ce que/ est- ce que », le verbe « pouvoir/ prendre », l'impératif.

Savoir – faire : L'interrogation sur le lieu, remplissez une fiche d'inscription, Demander son chemin, Expliquer les idées, interroger les faits.

Module:3 Parler de l'activité quotidienne

Faites des phrases simples en français, expressions des quantités.

Grammaire : Mettez les mots dans l'ordre, l'article partitif, l'usage du pronom « on », l'expression de quantité, les verbes pronominaux.

Savoir – faire : Parler d'une recette française, faire une commande dans un restaurant.

Module:4 Rendez-vous

Conversation téléphonique, Faire connaissance

Grammaire : L'adjectifs possessifs, les pronoms compléments d'objet direct « le, la, les », la conversation simple au téléphone.

Savoir-faire : Inviter quelqu'un, réunion à la famille.

Module:5 Exprimer d'intérêts/ des besoins

La Civilisation française

Grammaire : Les pronoms compléments d'objet indirect, les adjectifs démonstratifs, le futur, La Communication sur la culture et la civilisation de la France, Apprendre à connaître la France et les autres pays francophones.

Savoir-faire : Conseiller quelque chose, exprimer un souhait

Text Book

A. Leon Moreno, Adrien Payet, M.Stéfanou, Cédric Vial, J'AIME, 2022,
ISBN **:** 978-2-09-035748-6, Clé International, Paris.

References:

Sylvie Poisson-Quinton, Michèle Mahéo-Le-Coadic, Anne Vergne-Sirieys, FESTIVAL 1 Méthode de français, 2005, ISBN **:** 978-209-035320-4, Clé

International, Paris.

Jugurta Bentifraouine, David Clément-Rodriguez, ABC DELF, 2022, ISBN:978-209-035257-3, Clé International, Paris

Adrien Payet, Isabel Rubio, Emilio Ruiz, MERCI! 1 Méthode de Français, 2017, ISBN-978-209-038825-1, Clé International, Paris

MA340	OPTIMIZATION TECHNIQUES	OPC	3 - 0 - 0	3Credits

Pre-requisites: Nil

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.

Detailed Syllabus:

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

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.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. Kanti Swarup, 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.

PH340	Nanomaterials and Technology	OPC	3 – 0 – 0	3 Credits

Prerequisites: 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

Detailed Syllabus:

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.

Fullerenes and Carbon Nanotubes (CNT's): Introduction, Synthesis and purification, Preparation of fullerenes in the condensed phase, Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nano science and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process, Patterning monolayers, Types of clusters, Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction, Synthesis of Quantum Dots, Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surfaces, Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies, Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties, Nanosensors based on quantum size effects, Nano-bio-sensors.

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.

CY341	Chemistry of Nanomaterials	OPC	3 – 0 – 0	3 Credits

Detailed Syllabus:

Introduction: Review the scope of nanoscience and nanotecnology, understand the nanoscience in nature, classification of nanostructured materials and importance of nanomaterials.

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.

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.

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, MaGraw Hill, 2007.

2. B S Murty, P Shankar, BaldevRai, 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

BT391	BIOENERGY AND BIOFUELS	OPC	3–0–0	3 Credits

Prerequisites:

i. BT101 Engineering Biology

Course Outcomes:

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

CO1	Classify feedstocks for generation of bioenergy
CO2	Understand various bioenergy production processes
CO3	Understand various biofuels and technology involved in their production
CO4	Understand the concepts of biological production of hydrogen

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	3	3	2	-	-	3	3	2	1
CO2	3	3	3	2	3	2	3	3	2	-	2	3	3	3	3
CO3	3	3	3	2	3	2	1	3	-	-	3	2	2	3	3
CO4	3	3	3	2	3	1	2	3	-	-	2	2	3	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Unit I

Introduction: Classification of energy based on sources, bio-based energy, bioenergy types, Biopower, Bioheat, Biofuels, advanced liquid fuels, drop-in fuels, Syngas, biohydrogen, bio-based products. Feedstocks: Conventional and dedicated biomass feedstock. Residual Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and industrial waste.

Unit II

Bioconversion processes: Thermochemical processes, Direct Combustion, Pyrolysis, Gasification; Biochemical conversion – hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion; other techniques: trans-esterification

Unit III

Biofuels: First generation biofuels, Second generation biofuels, third generation biofuels; Pros and cons of Biofuels, Algal biofuels, Cyanobacteria and producers of biofuels, Biodiesel composition and production processes, Bioethanol, Biomethane, biobutanol, Engineering aspects of biofuels, Economics of biofuels,

Unit IV

Biohydrogen: Bioproduction of gases, Production of H_2 by photosynthetic organisms, Emergence of the hydrogen economy, Microbial Fuel Cells and other technological advancements.

Text Books:

1. Brown, R. C., & Brown, T. R. (2014). *Biorenewable resources: Engineering new products from agriculture* (2nd ed.). Wiley-Blackwell.
2. Soetaert, W., & Vandamme, E. J. (2009). *Biofuels* (1st ed.). Wiley.
3. Klass, D. L. (1998). *Biomass for renewable energy, fuels and chemicals* (1st ed.). Academic press.
4. Nelson, V. C., & Starcher, K. L. (2016). *Introduction to bioenergy* (1st ed.). CRC Press.
5. Dahiya, A. (2015). *Bioenergy: Biomass to biofuels* (1st ed.). Academic Press.

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:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	-	-	-	-	-	-	1	1	1
CO2	3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
CO3	3	3	1	1	-	-	-	-	-	-	-	-	2	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	-	1	-	-
CO5	1	-	1	-	-	-	2	-	-	-	-	1	2	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Detailed Syllabus:

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.

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.

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.

Carbon Nanomaterials: Synthesis of Carbon Bucky-Balls, List of Stable Carbon Allotropes Extended, Fullerenes, Metallofullerenes, Solid C60, Bucky Onions, Nanotubes, Nanocones.

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

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.

Applications: Self-Assembly and Molecular Manufacturing, Surfactant Based System Colloidal System Applications, Functional Materials Applications, Commercial Processes of Synthesis of Nanomaterials.

Nano-inorganic Materials of $CaCO_3$ Synthesis, Hybrid Waste Water Treatments Systems, Electronic Nanodevices,

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.

Readings:

1. Kulkarni Sulabha 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, Joydeep Dutta, 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.

CE390	INFRASTRUCTE FOR SMART CITIES	OPC	3-0-0	3 Credit

(This course is not offered to Civil Engineering Students)

Prerequisites None

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

CO1	Acquaint knowledge on smart cities planning and development
CO2	Develop work break down structure, scheduling and project management of smart cities
CO3	Work out the most energy efficient technique

Detailed Syllabus:

6. **Fundamental of smart city & Infrastructure:** Introduction of Smart City, Concept of smart city, Objective, History of Smart city world and India. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems
7. **Planning and development of Smart city Infrastructure**: Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security, Project management.
8. **Intelligent transport systems:** Smart vehicles and fuels, GIS, GPS, Navigation system, traffic safety management, Internet of Things (IoT)
9. **Management of water resources and related infrastructure:** Storage and conveyance system of water, sustainable water and sanitation, sewerage system, flood management, conservation system
10. **Infrastructure Management system & Policy for Smart city**: Integrated infrastructure management systems for smart city, Infrastructure management system applications for existing smart city. Worldwide policies for smart city Government of India - policy for smart city, Mission statement & guidelines, Smart cities in India, Case studies of smart city.

Readings:

6. Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia by Anthony Townsend
7. Beyond Smart Cities: How Cities Network, Learn and Innovate, Tim Campbell, ISBN: 978-1-84971-426-6
8. Grig N.S., Infrastructure engineering and management, Wiley-Interseience, 1988
9. Hudson W.R., Haas R., Uddin W., Infrastructure Management, McGraw-Hill, 1997
10. Mission statement &guidelines on Smart City Scheme. Government of India - Ministry of Urban Development

CS390	Database Management Systems	OPC	2 – 0 – 2	3 Credits

Pre-requisites:

i. Introduction to Algorithmic Thinking and Programming (CS101)

ii. Introduction to Algorithmic Thinking and Programming Lab (CS102)

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

CO1	Construct database schema using Database models at conceptual level identifying entities and relationships among entities using E-R and relational models. (Apply)
CO2	Construct database and implement queries using SQL constructs for a given requirement specification. (Apply)
CO3	Construct database design using Normalization and Functional Dependencies to store information without redundancy. (Analyze)
CO4	Design and develop an application using stored procedures for a given requirement specification. (Apply)
CO5	Design and develop an application with database connectivity for a given requirement specification. (Apply)
CO6	Implement database maintenance and control using authorization access control, transaction and concurrency management and recover constructs. (Apply)

Course Articulation Matrix:

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	L	L	S				M	L			S	S	L
CO2	S	M	L	L	S				M	L			S	S	L
CO3	S	M	S	L	S				M	L			S	S	M
CO4	S	M	M	L	S			S	S	M			S	S	L
CO5	S	M	M	L	S	S	S	S	S	M	L	L	S	S	S
CO6	S	M	M	L	S			S	S	M			S	S	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Design, Database Engine, Database and Application Architecture

Database Users and Administrators, History of Database Systems

Introduction to the Relational Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, The Relational Algebra

Introduction to SQL: Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database

Intermediate SQL: Join Expressions, Views, Transactions, Integrity Constraints, SQL Data Types and Schemas, Index Definition in SQL, Authorization

Advanced SQL: Accessing SQL from a Programming Language, Functions and Procedures, Triggers, Recursive Queries, Advanced Aggregation Features

Database Design Using the E-R Model: Overview of the Design Process, The Entity-Relationship Model, Complex Attributes, Mapping Cardinalities, Primary Key, Removing Redundant Attributes in Entity Sets, Reducing E-R Diagrams to Relational Schemas, Extended E-R Features, Entity-Relationship Design Issues, Alternative Notations for Modeling Data

Relational Database Design: Features of Good Relational Designs, Decomposition Using Functional Dependencies, Normal Forms, Functional-Dependency Theory, Algorithms for Decomposition Using Functional Dependencies, Decomposition Using Multivalued

Dependencies, More Normal Forms, Atomic Domains and First Normal Form, Database-Design Process, Modeling Temporal Data

Introduction to Indexing, Query processing and optimization, Transactions, concurrency control and recovery

List of Experiments:

1. E-R diagrams
2. SQL Query Language, Data Definition Language
3. SQL Queries, Operations, Set Operations, Null Values
4. Aggregate Functions
5. Nested Subqueries
6. Join Expressions
7. Views

8. Transactions
9. Integrity Constraints
10. SQL Data Types and Schemas
11. Index Definition in SQL
12. Authorization
13. Accessing SQL from a Programming Language
14. Functions and Procedures
15. Triggers
16. Recursive Queries

Reading List:

1. Abraham Silberschatz; Henry F Korth; S Sudarshan, Database System Concepts, 7th Edition, New York, NY: McGraw-Hill Education 2020
2. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 2nd Edition, McGraw-Hill, Inc., 2000

EE390	Introduction to Electric Vehicles	OPC	3–0–0	3 Credits

Pre-requisites: NIL

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

CO1	Calculation of the energy losses and performance efficiency of a conventional vehicle
CO2	Identify the power flow in electric and hybrid electric vehicles
CO3	Understand the global developments, standards and emerging research in EV Sector
CO4	Analyze the performance of Battery energy systems for electric vehicles
CO5	Illustrate the configurations of different types of EV Charging Stations

Detailed Syllabus:

UNIT I: Basic Concepts of Vehicle Energy and Fuel Consumption

Main elements of the energy conversion scheme in vehicle, Energy domains in vehicle propulsion systems, upstream processes, Energy density of on-board energy carriers, Fuel Efficiency, Pathways to better fuel economy, Energy losses – Engine losses, Drive train losses, Aerodynamic Friction losses, Rolling Friction losses, Uphill Driving force, Inertial forces, Performance and Drivability – Vehicle Operating modes, Energy Demand in Driving Cycles.

UNIT II: Vehicle Power Management in Electric and Hybrid Electric Vehicles

Configurations of Hybrid Electric Vehicles (HEVs) and Electric Vehicles (EVs), Power flow in HEVs – Series, Parallel, Series-Parallel and Power flow in EVs, Regenerative Braking, Battery Technologies, Role of Power Electronics and Electric Machines, Advantages over conventional vehicles.

UNIT III: Global & National Developments and Technical Standards in EV Sector

Global EV Outlook – Trends and Developments in EV markets, Promotion, Polices, IEA Technology Road map on Electric and Plug-in Hybrid Vehicles, Updates of National Electric Mobility Mission Plan (NEMMP) and Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme and Energy Efficiency Services Limited, Progress and plans of OEMs, Developments in EV charging stations, International Electrotechnical Commission (IEC) Standards on Battery Back, Wired & Wireless Charging, Electric Vehicle Conductive DC & AC Charging Systems by Automotive Industry Standards Committee (AISC) India.

UNIT IV: Battery Technologies and their performance in EVs

Battery Parameters, Battery Types-Lead Acid, Nickel based, Sodium based, Lithium, Metal Air based batteries, Comparison, Battery modeling, Use of Batteries in EVs, Ultracapacitor, Flywheel, Battery Charging, Battery Fast Charging, Battery Discharging, Battery efficiency, Battery Performance, Battery Testing, Battery Management System – SOC, SoH, Factors affecting failures of Battery.

UNIT V: EV Charging Infrastructure

Wired Charging Station (Static): Electric vehicle supply equipment, classification of Electric vehicle supply equipments, DC Charging Station-configuration, performance, AC Charging Station-configuration, performance, advantages and disadvantages of wired charging station, IEC standards for wired charging Station.

Wireless Charging Station (Dynamic): Composition of the wireless charging system, Wireless charging challenges, IEC Standards for wireless charging Station.

References:

1. Lino Guzzella and Antonio Sciarretta “Vehicle Propulsion Systems”, Springer, 2005
2. Xi Zhang and Chris Mi “Vehicle Power Management” Springer, 2011
3. James Larminie, John Lowry, “Electric Vehicle Technology Explained,” John Wiley & Sons Ltd.
4. Sandeep Dhameja, “Electric Vehicle Battery Systems,” Newnes.
5. Naoui Mohamed, Flah Aymen, Mohammed Alqarni, Rania A. Turky, Basem Alamri, Ziad M. Ali, Shady H.E. Abdel Aleem, “A new wireless charging system for electric vehicles using two receiver coils,” Ain Shams Engineering Journal, Volume 13, Issue 2, 2022.
6. Online: https://www.iea.org/, IEA Global EV Outlook 2022
7. Online: https://heavyindustries.gov.in/writereaddata/Content/NEMMP2020.pdf, National Electric Mobility Mission Plan (NEMMP) 2020,
8. Online: https://fame2.heavyindustries.gov.in/, National Automotive Board (NAB), Ministry of Heavy Industries, Govt of India
9. Online: https://www.iso.org/, International Organization for Standardization
10. Online: https://www.araiindia.com/, Automotive Research Association of India (ARAI),
11. Online: https://www.siam.in/, Society of Indian Automobile Manufacturers (SIAM)
12. Online: https://eeslindia.org/en/home/, Energy Efficiency Services Limited,

EC390	Elements of Statistical Learning	OPC	3-0-0	3 Credits

Course Outcomes: After the completion of the course the 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 trade-offs and performance of communications systems.

Course Articulation Matrix:

PO/ PSO / 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
CO1	M	-	-	-	S	M	-	-	-	-	-	S
CO2	-	S	-	-	S	M	-	-	M	-	-	S
CO3	M	-	-	-	S	-	-	-	-	-	-	S
CO4	-	-	-	-	-	S	-	-	M	L	-	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Supervised learning: Definitions, issues with overfitting and underfitting, linear methods for regression, regularization / ridge regression, model assessment and selection, Bayesian learning, linear methods for classification: linear discriminant analysis, probabilistic generative and discriminative models, Bayesian logistic regression

Kernel Methods: 1-dimensional kernel smoothers, local regression, kernel density estimation and classification, radial basis function networks, SVM, multiclass SVMs, Mixture models for density estimation and classification

Unsupervised learning: Cluster analysis; K-means clustering, combinatorial algorithms, self-organizing maps, mixtures of Gaussians, Principal component analysis: probabilistic PCA, Kernel PCA.

Text Books:

1. Trevor Hastie, et al, “The elements of statistical learning”
2. Christopher M. Bhishop, “Pattern recognition and machine learning".

ME390	ALTERNATIVE SOURCES OF ENERGY	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	1	-	3	3	-	-	-	-	2	-	-
CO2	3	3	3	2	-	1	3	-	-	-	-	2	-	-
CO3	3	3	3	3	2	1	3	-	-	-	-	2	-	-
CO4	3	3	3	1	2	1	3	-	-	-	-	2	-	-
CO5	2	3	2	1	1	1	3	-	-	-	-	2	-	-
CO6	2	3	2	1	1	1	3	-	-	-	-	2	-	-

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming;Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

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

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel, and Array construction; Photovoltaic thermal systems.

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

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

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.

ME391	ROBUST DESIGN	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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:

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.

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.

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.

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.

MM390	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 various product forms of engineering materials
CO2	Discuss appropriate material processing techniques
CO3	Explain principles involved in different processing methods
CO4	Select suitable processing technique for a given material and application

Course Articulation Matrix:

PO/PSO / 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	PSO1	PSO2	PSO3	PSO4
CO1	M	-	-	-	-	L	M	-	-	-	-	-	L	-	-	-
CO2	M	-	-	-	-	S	S	-	-	-	-	-	L	-	-	-
CO3	M	-	-	-	-	M	M	-	-	-	-	-	L	-	-	-
CO4	M	-	-	-	-	L	M	-	-	-	-	-	L	-	-	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Syllabus

CLASSIFICATION OF MATERIALS AND PRODUCTS:

Metals and alloys, oxide and non-oxide ceramics, polymers, and composites; various forms of engineering materials as consumer products and their applications

METAL CASTING AND CERAMIC FORMING:

Overview of casting technology, melting and pouring, solidification and casting of metals, casting defects, casting quality, Forming of ceramics by slip casting, pressure casting, gel casting, tape casting.

MECHANICAL FORMING AND SHAPING:

Overview of metal forming, friction and lubrication in metal forming, bulk deformation processes of metals - rolling, forging, extrusion, drawing, sheet metal forming; extrusion and injection molding of ceramics

POWDER PROCESSING AND SINTERING:
Characteristics of powders, processing of metallic and ceramic powders, production of bulk products and design considerations, conventional pressing and sintering methods, alternative pressing (CIP, HIP) and sintering (microwave, spark plasma) techniques.

THIN FILMS AND COATINGS:

Films – Physical and chemical vapour deposition techniques including molecular beam epitaxy, laser ablation and hot wire and microwave CVD techniques. Coatings – dry and wet deposition techniques including electro-deposition, spin coating, sol-gel, Spray drying, Doctor blade technique, ink printing, etc;

Text Books:

1. S. Kalpakjian, S. R. Schmid, Manufacturing Engineering and Technology, Pearson, 2014
2. Vukota Boljanovic, Metal Shaping Processes - Casting and Molding, Particulate Processing, Deformation Processes, and Metal Removal, Industrial Press, 2010
3. Phillip Boch, Ceramic Materials - Processes, Properties, and Applications, Wiley, 2010
4. James S. Reed, Principles of Ceramics Processing, Wiley, 1995
5. D.L. Smith, Thin-film deposition: principles and practice, McGraw Hill, 1995

HS391	Business English for Engineers	OPC	3 – 0 – 0	3 Credits

Pre-requisites: English for Technical Communication

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

CO1	Understand formal vocabulary and expressions in business environment
CO2	Compose various types of business documents and respond professionally tocriticism
CO3	Convene and participate effectively in on-site meetings and online meetings
CO4	Develop practical telephone skills, presentation skills, and understand theimportance of networking

Detailed syllabus

Business vocabulary- Business idioms- Business English writing-content writing- describing things and events- describing process, cause and effect, criticizing, recommending-developing an argument -drafting circulars-notices- memos-office orders- minutes of meetings-letters and e-mails

Conducting and participating in meetings- chairing-setting agenda- managing conversation- participating-turn taking- listening and taking notes- being diplomatic- agreeing-disagreeing - making speech powerful with metaphors- getting most out of a conference -how to sound credible

Presentation-connecting with your audience-handling difficult questions-becoming a charismatic speaker- influencing people-hacks for improving business English- dealing with criticism-clarifying – listening-running a brainstorming session- organizing and defending ideas -receiving feedback-getting good customer service-staying positive- - how to say no- negotiations-making a deal-doing ground work

Telephoning- checking and clarifying -listening to different accents-intonation-following up with contacts-meeting new people-adapting to change- making appropriate questions and relevant answers -handling people with negativity -telephone English tips-selling your ideas- diplomatic and direct language-tips for successful presentation- networking skills- using socialmedia platforms- achieving goals

References:

Bhalla, Prem P. *Business English: A Complete Guide for All Business and Professional Communications*. V&S Publishers, 2018

Desk, Bus. *Powerful Telephone Skills: A Quick and Handy Guide for any Manger or BusinessOwner.* Career Press, 2005

Lent, Richard M. *Leading* Great Meetings: *How to Structure Yours for Success*. Meeting forResults,2015

Mascull Bill. *Business Vocabulary in Use: Advanced*. Cambridge UP,2010

Taylor Shirley and V Chandra. *Communication for Business: A Practical Approach.* Pearson,2010

SM391	Professional Ethics and Values	OPC	3 – 0 – 0	3 Credits

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

CO1	Understand the basic tenets of professional ethics
CO2	Develop professionalism and inclusiveness
CO3	Make ethical decisions and contribute to sustainable development
CO4	Adopt ethical practices in workplace

Detailed syllabus

Introduction to human values and professional ethics-attitudes-ethical codes -basic tenets of professionalism-professional integrity- ethics and employee commitment-ethics and investor loyalty-ethics and customer satisfaction-ethics and profitability-environmental ethics- evolution of business ethics -theories of ethics

Uses of ethical theories-engineering as social experimentation-ethics and start-ups-safety- responsibilities- rights-organizational values-intellectual property rights and ethical issues--global issues in ethics -defining and prioritizing stakeholders-impact of culture and time on business ethics-Professional ethics and social responsibility-socially responsible ethical decisions-promoting professional ethics and ethic and social responsibility-corporate responsibility

Unethical behaviours in organization and human nature -ethical issues and dilemmas in business- conflicts of interest-bribery-corporate intelligence-discrimination-sexual harassment-fraud-consumer fraud-financial misconduct-insider trading-privacy issues-corporate governance and stakeholder relationships-hiring ethical people-codes of ethics and codes of conduct-ethical decision making-ethical training-respecting employee diversity-Being an ethical citizen in globaleconomy-global sustainability-global citizenship

Ethical decision making and leadership-using ethical decision-making framework to improve ethical decisions-leadership styles and ethical decisions-habits of strong ethical

leaders-Loyalty to organization-loyalty to brand and consumers-contributing to positive work atmosphere- financial integrity-criticizing organization and whistle blowing-diversity and inclusion in workplace-accommodating different abilities and faiths-income inequalities

References:

Byars,Stephen M.and Kurt Stanberry.*Business Ethics*.Openstax,2018.

Collins, Dennis and Patricia Kanashiro.*Business Ethics:Best Practices for DesigningandManaging Ethical Organizations*. Sage, 2021.

Ferral,O.C., John Fraedrich and Linda Ferrel*. Business Ethics:Ethical Decision Making andCases.*8th Edition,Cengage.2011.

Koehn, Daryl. *The Ground of Professional Ethics*.

Routledge,2001Subramanian, R. *Professional Ethics*.OUP,2013.

PH391	Advanced Materials	OPC	3-0-0	3 Credits

Syllabus:

1. **Nanomaterials and Biomaterials:** Origin of nanotechnology, Classification of nanomaterials, physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapor deposition (PVD), chemical vapor deposition (CVD), sol-gel, electrodeposition, ball milling. Overview of biomaterials. Biomaterials, bioceramics, biopolymers. Tissue grafts, soft tissue applications, cardiovascular implants, Biomaterials in ophthalmology, orthopedic implants, dental materials.

2. **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, introduction to finite element analysis and design.

3. **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.

4. **Superconducting materials:** Types of superconductors, 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, SQUID, etc.

5. **Smart materials and Device Applications:** Introduction, Input–output decision ability, classification of the materials based on the input and output and their working principle (eg. piezoelectric, electrostrictive, magnetostrictive, multiferroics, thermal conductivity-based materials etc.) - Polycrystalline, amorphous, liquid crystalline materials - Artificial structures, surfaces, hetero-structures - Devices based on conductivity changes, devices based on changes in optical response, Devices based on magnetization.

Reference:

1. Nano: The Essentials, T. Pradeep, Tata McGraw-Hill, 2012.
2. Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B.B. Rath, James Murday, Springer, 2013.
3. Composite Materials, Krishan K Chawla, Springer, 2006.
4. Optics, Eugene Hecht, A.R. Ganesan, Pearson, 2019. 5. Introduction to Solid State Physics, Charles Kittel, Wiley, 2012.

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	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-
CO2	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-
CO3	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-
CO4	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-
CO5	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence: Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

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.

Chromatorgraphy 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. Thermoanalytical methods: Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations Electroanalytical methods: Coulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric Sensors, Applications.

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 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.

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

Syllabus:

Ordinary Differential Equations: Numerical solutions of initial value problems: Definition, existence of solution, Difference equations, stability, Error and convergence analysis. (2)

Single step methods: Taylor series method, Euler method, Picard's method of successive approximation, Runge Kutta Method. (5)

Multi step methods: Predictor-Corrector (PC) method, Euler PC method, modified, Milne and Adams Moulton PC method. System of first order ODE, higher order IVPs. Numerical solutions of BVP - Linear BVP, finite difference methods, shooting methods, Newton's method for system of equations, stability, error and convergence analysis, nonlinear BVP, higher order BVP. (12)

Partial Differential Equations: Well posed PDEs, Classification of PDEs, Finite difference approximations to partial derivatives, convergence and stability analysis. (2)

Parabolic equations: Crank-Nicolson scheme, tri-diagonal system, Schmidt's two level, multilevel explicit methods, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis. (10)

Hyperbolic equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.(6)

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods. (5)

Text Books:

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.

Reference Books:

1. G. E. Forsythe, and W. R. Wasow, W. R. Finite-Difference Methods for Partial Differential Equations, Applied Mathematics Series, 1960.
2. C. F. Gerald, Applied Numerical Analysis. Pearson Education India, 2004.

BT491	ETHICS AND IPR	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 concept of engineering ethics
CO2	Understand the agreements, treaties and the procedures involved in patent filing
CO3	Analyze the databases and formalities pertaining to patent agreements

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	3	3	-	-	2	-	-	3	2	3
CO2	2	-	-	-	-	3	3	-	-	2	-	-	3	-	3
CO3	2	-	-	-	-	3	3	-	-	2	-	-	3	-	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Unit I

Engineering Ethics :Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

Unit II

Agreements and Treaties, History of GATT & TRIPS Agreement, Madrid Agreement; Hague Agreement, WIPO Treaties; Budapest Treaty; PCT, Indian Patent Act 1970 & recent amendments, Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition, Specifications: Provisional & complete.

Unit III

Patent databases- Patent filing procedures, Time frame& cost; Status of patent applications filed, Precautions while patenting – disclosure/non-disclosure, Financial assistance for patenting , Patent licensing and agreement, Patent infringement.

Text Books:

1. Martin, M. W., & Schinzinger, R. (2005). *Ethics in engineering* (4th ed.). McGraw Hill Higher Education.
2. Govindarajan, M., Natarajan, S., & Senthil Kumar, V. S. (2004). *Engineering ethics*. PHI Learning.
3. Wadhera, B. L. (2010). *Law relating to intellectual property* (5th ed.). Universal Law Publishing.

Bansal, P. (2015). *IPR handbook for pharma students and researchers*. Pharma Med Press.Dahiya, A. (2015). Bioenergy: Biomass to biofuels (1st ed.). Academic Press.

CH490	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:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	2	1	-	-	-	-	-	-	-	-	2	1
CO2	3	1	3	2	1	-	-	-	-	-	-	-	-	2	1
CO3	3	1	3	2	1	-	-	-	-	-	-	-	-	2	1
CO4	3	1	3	2	1	-	-	-	-	-	-	-	-	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Detailed Syllabus:

Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprint, carbon capture, storage and utilization (CCS&U).

CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion.

CO_2 capture agents and processes: Capture processes, CO2 capture agents, adsorption, ionic liquids, metal organic frameworks

CO_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration.

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.

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.

Readings:

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 Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry, TERI, Energy and Resources Institute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO2 Management Technologies, CRC Press, 2014.
4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO2) 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, 2014.

CE490	DISASTER MANAGEMENT	OPC	3-0-0	3 Credit

(This course is not offered to Civil Engineering Students)

Prerequisites None

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

CO1	To impart knowledge about the disaster Management
CO2	To introduce the fundamental concepts relevant to various aspect of disaster
CO3	To enable the students to understand the factors that causes the disaster

Detailed Syllabus:

5. **Understanding Disasters:** Understanding the Concepts & definitions of Disaster, Hazard, Vulnerability, Risk, Capacity–Disaster, Development & management, Types, Trends, Causes, Consequences and Control of Disasters: Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters
6. **Disaster Management Cycle and Framework:** Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment
7. **Disaster Management in India:** Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter Governmental Agencies
8. **Applications of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System

Readings:

4. Disaster Management by W. Nick. Carter, 1991: Asian Development Bank, Manila
5. Introduction to International Disaster Management by D. P. Coppola, 2007, Elsevier Science (B/H), London.
6. Manual on natural disaster management in India by M C Gupta, NIDM, New Delhi

CS490	Web Programming	OPC	2 – 0 – 2	3 Credits

Pre-requisites:

i. Introduction to Algorithmic Thinking and Programming (CS101)

ii. Introduction to Algorithmic Thinking and Programming Lab (CS102)

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

CO1	Discover the basic web components and development environment. (Apply)
CO2	Design and develop client-side scripting techniques (Apply)
CO3	Design and develop server-side scripting techniques (Apply)
CO4	Build real world applications using client side and server-side scripting languages (Apply)
CO5	Analyze SOAP and RESTful web Services. (Analyze)

Course Articulation Matrix

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	M	L	M								M	L	L
CO2	S	M	S	L	S				M		L		S	M	L
CO3	S	M	S	L	S				M		L		S	M	L
CO4	S	M	S	L	S				S		M		S	M	L
CO5	S	M	S	M	S				M				S	M	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

HTML5 - List - Tables - Images - Forms - Frames - Cascading Style sheets, XML Document type definition - XML Schemas, Document Object model.

Java Script - Control statements - Functions - Arrays - Objects - Events –Random number Generation - Dynamic HTML with Java Script – Ajax, JSON – Introduction, Responsive Web Design, Front end framework- Angular JS.

Different kinds of servers - web servers – Apache & nginx, File servers – time servers- DB servers. Server-side scripting languages Introduction: PHP basics - PHP server applications (No DB). Introduction to NodeJS – asynchronous nature of nodejs – simple apps Integrating application with DB – DB drivers- Integrate NodeJS with NOSQL, Integrate NodeJS with SQL.

Web Architecture & Web services: MVC introduction- thin clients Vs Thick clients. Web services – Introduction- SOAP, REST – writing a RESTful service (nodejs + expres). SOAP Vs REST.

List of Experiments:

1. Construct static web pages by make use of basic HTML5.
2. Construct fascinating web pages by make use of CSS3.
3. Construct XML documents – formatting, styling, and schema.
4. Construct an interactive web page by make use of client-side scripting.
5. Create a required environment to develop a complete web application.
6. Develop a backend application for any specific real-world application.
7. Construct a static web application by make use of framework.
8. Develop a complete dynamic web application for any real-world application using framework.

Reading List:

1. Paul Deitel, Harvey Deitel, Abbey Deitel, “Internet and World Wide Web How to Program”, Pearson, Fifth Edition, 2011.
2. Jeffrey C. Jackson, “Web Technologies – A Computer Science Perspective”, Pearson Education, Fourth Edition, 2012.
3. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, “Fullstack React: The Complete Guide to React JS and Friends”, Fullstack.io, 2017.
4. Brown, Ethan, “Web Development with Node and Express: Leveraging the JavaScript Stack”, O'Reilly Media, 2019.
5. Dayley B., “Node.js, MongoDB, and AngularJS Web Development”, Addison-Wesley Professional, 2014.

EC490	Computer Vision	OPC	3-0-0	3 credits

Prerequisites: None

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

CO1	Development of algorithms and techniques to analyze and interpret the visible world.
CO2	Apply feature extraction methods for computer processing.
CO3	Implement pattern recognition algorithms for real world problems
CO4	Design of face detection and recognition algorithms

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	3	2	-	-	1	-	-	-	-	2	2
CO2	3	3	3	2	2	2	-	2	-	-	-	-	2	2
CO3	3	3	3	3	3	-	-	-	2	-	-	-	2	2
CO4	2	3	2	2	2	2	-	2	2	-	-	-	2	2

Detailed Syllabus:

Digital Image Formation and Low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Digital Image Formation: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative , Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation,

Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

sPattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Use Cases on Finger print recognition, Face detection and recognition, Object tracking, medical Diagnosis etc

Reading:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, PHI Learning 2009.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson Education.

EE490	Introduction to Smart Grids	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 different categories, features and operation of Smart grid
CO2	Apply the control and artificial intelligence techniques for the Smart Grid operation
CO3	Understand operation and importance of communication technologies and control in Smart Grids

Detailed Syllabus:

Introduction to Smart Grid and Smart Grid Architecture: Smart Grid Working and Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Indian Smart Grid – Key Challenges for Smart Grid - Components and Architecture of Smart Grid Design – Fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation

Tools and Techniques for Smart Grid: Computational Techniques – Static and Dynamic Optimization Techniques – Computational Intelligence Techniques – Evolutionary Algorithms – Artificial Intelligence techniques.

Communication Technologies and Control of Smart Grid: Introduction to Communication Technology – Synchro-Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS), Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

References:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press,2013
2. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010.

ME490	ENTREPRENEURSHIP	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil.

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

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

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	-	2	-	3	3	2	3	-
CO2	-	-	-	-	-	2	3	3	-	3	2	2	2	-
CO3	-	-	-	-	-	2	-	3	-	3	2	2	2	-
CO4	-	-	-	-	-	2	3	3	-	3	3	2	-	-
CO5	-	-	-	-	-	-	-	3	2	3	2	2	2	-
CO6	-	-	-	-	-	-	-	2	2	-	3	2	2	-

Detailed syllabus:

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and productdevelopment process; Market survey and assessment; choice of technology and selection of site.

Planning a Small-Scale Enterprise: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE: Financial management issues; Operational/project management issues inSSE; Marketing management issues in SSE; Relevant business and industrial Laws.

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, 1998.
4. Bruce R Barringer and R Duane Ireland, “Entrepreneurship: Successfully Launching NewVentures”, 3rd Edition, Pearson Education, 2013.

ME491	PROJECT MANAGEMENT	OPC	3 - 0 - 0	3 Credits

Pre-requisites: Nil

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

CO1	Understand the importance of projects and its phases.
CO2	Analyze projects from marketing, operational and financial perspectives.
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization.

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	2	-	-	3	2	3	2
CO2	3	2	-	-	-	-	-	2	-	-	3	2	3	2
CO3	3	2	3	3	-	-	-	-	-	-	3	2	3	2
CO4	-	3	3	3	2	-	-	-	3	-	3	2	3	3
CO5	3	3	3	3	2	-	-	-	-	-	3	2	3	3

Detailed syllabus:

Introduction: Introduction to Project Management, History of Project Management, Project LifeCycle.

Project Analysis: Facets of Project Analysis, Strategy and Resource Allocation, Market andDemand Analysis, Technical Analysis, Economic and Ecological Analysis.

Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects.

Network Methods in PM: Origin of Network Techniques, AON and AOA differentiation, CPMnetwork, PERT network, other network models.

Optimization in PM: Time and Cost trade-off in CPM, Crashing procedure, Scheduling whenresources are limited.

Project Risk Management: Scope Management, Work Breakdown Structure, Earned ValueManagement, Project Risk Management.

Reading:

1. Prasanna Chandra, “Project: A Planning Analysis”, Tata McGraw Hill Book Company, NewDelhi, 4th Edition, 2009.
2. Cleland, Gray and Laudon, “Project Management”, Tata McGraw Hill Book Company, NewDelhi, 3rd Edition, 2007.
3. Jack R. Meredith and Samuel J., Jr. Mantel, “Project Management - A Managerial Approach”, John Wiley, 6th Edition, 2011.

MM490	Materials Testing & Analysis	OPC	3-0-0	3 Credits

Pre-requisites: PH101-Engineering Physics, CY101-Engineering chemistry
Course Outcomes: At the end of the course, student will be able to:

CO1	Describe important physical properties of materials
CO2	Discuss procedures that can be used to identify or measure mechanical properties.
CO3	Analyze the microstructure and understand structure-property correlations
CO4	Select suitable material for a given purpose applying knowledge of material testing and structure of metallic materials

Course Articulation Matrix:

PO/ PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	S	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-
CO2	S	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-
CO3	S	-	-	-	-	-	-	-	-	-	-	-	-	-	M	-
CO4	-	-	S	S	-	-	-	-	-	M	-	S	-	M	L	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Syllabus:

INTRODUCTION:

Structures & Properties of engineering materials. Comparison of physical, thermal, and mechanical properties of metallic, ceramic, and polymeric materials, and composites. Scientific rationale for mechanical properties; cohesion between atoms, interatomic bonds, different levels of structures: atomic, crystal, micro, and macro and mega structures.

MECHANICAL TESTING:

Tension, Compression, Hardness, Torsion, Impact, Fatigue, and Creep

STRUCTURAL CHARACTERIZATION & ANALYSIS:

X-ray diffraction, optical microscopy & electron microscopy.

Text Books:

1. C. Suryanarayana, Experimental Techniques in Materials & Mechanics, CRC Press, 2011
2. D.Brandon, W. D. Kaplan, Microstructural Characterization of Materials, Wiley, 2008
3. P.R. Khangaonkar, Introduction to Material Characterization, Penram publishing, 2010

PH490	Science and Engineering of Materials	OPC	3-0-0	3 Credits

Unit-I

Crystallography: Space lattice, Basis, Group theory, Space groups, Unit Cell and Lattice parameters, Bravais Lattices, crystal systems (3D), co-ordination number, packing fraction of SC, BCC and FCC, Miller indices, separation between successive (hkl) planes. X-ray diffraction, Bragg's law, crystal structure determination. **(9)**

Unit-II

Magnetic materials: Introduction, Classification of magnetic materials, Weiss theory of ferromagnetism, Concept of magnetic domain, Magnetic hysteresis, Curie temperature, hard and soft magnetic materials, B-H product, Anti-ferromagnets, Ferrimagnets and their applications, Magneto-resistance - GMR, and TMR, applications. **(8)**

Unit-III

Advanced Functional Materials: Composites: Introduction, matrix, reinforcement, Fiber reinforced plastics, fiber reinforced metals. Types of composites: Polymer Matrix Composites (PMC), Ceramic Matrix Composites (CMC), Metal Matrix Composites (MMC), Carbon composites. Advanced materials: High temperature materials, Bio-materials and Nano-materials - Introduction, Preparation methods, Properties and Applications. Ongoing research/research perspectives. **(9)**

Unit-IV

Photovoltaics: Introduction, Solar radiation spectrum, Photovoltaics working principle, Structure and I-V characteristics, Fabrication methods, Operating principles. Properties of photovoltaics - Power conversion efficiency, Quantum efficiency. Emerging PV technologies, and Applications. Ongoing research/research perspectives. **(8)**

Unit-V

Characterization of Physical properties: Powder X-ray Diffraction – Four probe resistivity, Heat capacity, Hall effect, Magnetic property measurements, Optical

Spectroscopy, Optical Microscopy, Scanning Electron Microscopy, Non-Destructive Testing (NDT) methods. **(7)**

Text books:

1. William D. Callister, Jr. and David G. Rethwisch, 2014, "***Materials Science and Engineering, An Introduction"***, 9E, WILEY Publications.
2. M. A. Wahab, 2015,***"Solid State Physics-Structure and Properties of Materials",*** 3E, Narosa Publishing House Pvt. Ltd. - New Delhi.
3. Sujata V Bhatt,2018, "***Bio-materials"***, 3rd Edition, Narosa Publications.

Reference books:

4. B. D. Cullity, 2001, ***"Elements of X-ray Diffraction"*** 3rd Edition, Pearson Education Limited.
5. David C Jiles, 2015, ***"Introduction to Magnetism and Magnetic Materials"***, 3rd Edition, CRC Press.
6. B. D. Cullity, 2008, ***"Introduction to Magnetic Materials"***, 2nd Edition, Wiley-IEEE Press.

MA490	Applied Linear Algebra	OPC	3-0-0	3 Credits

Pre-requisites: Basic knowledge of Differential Calculus,

Differential Equations and Matrices.

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

CO1	Understand the concept of Vector space, Basis and Dimension.
CO2	Determine the angle between two vectors and able to find orthogonal basis.
CO3	Find Singular Value Decomposition of a given matrix.
CO4	Discuss convergence of iterative methods for solving Ax=b.

Mapping of course outcomes with program outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4				`								

Vector Spaces: Vector spaces and subspaces – Review of solving system of linear equations – Basis and dimension – Linear transformations – Applications in electric circuits. (10)

Inner Product Spaces and Orthogonality: Vector norms – Inner product spaces – orthogonal vectors and subspaces – Cosines and projections onto lines – Projections & least squares – Orthogonal bases and Gram-Schimdt process. (10)

Positive definite matrices: Normal matrices – Positive definite matrices- Pseudo inverse – Singular value decomposition and applications. (10)

Iterative Methods: Introduction – Matrix norm & Condition number – Computation of eigenvalues – Iterative methods for solving Ax=b (6)

Perron Frobenius theory: Introduction – Positive matrices – Nonnegative matrices – Stochastic matrices – Markov Chains.
(6)

Text/ Reference Books:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson, 2015
2. Carl D. Mayer, Matrix Analysis and Applied Linear Algebra, SIAM, 2004.
3. Gilbert Strang, Linear Algebra and its Applications, 4th Edition, Cengage Learning Pvt Ltd., 2008.

SM490	Human Resource Management	OPC	3 – 0 – 0	3 Credits

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

CO1	Develop awareness on the evolution, current issues, practices and trends of human resource management and its effective management in organizations
CO2	Gain an understanding of human resource management functions and practices including man power planning, recruitment, selection methods, training, and performance appraisal
CO3	Secure the ability to conduct job analysis and job evaluation, develop job descriptions, and determine compensation policies.
CO4	Develop an understanding of employee welfare programs, incorporation of health-care policies and safety concerns; industrial relations and illustrate the enduring global contexts of International HRM

Detailed syllabus

Concept, Nature and Scope of HRM: History and Evolution of HRM- Growth and Development of HRM in India-Emerging Trends of HRM in a globalised economy- Outsourcing- Globalization- Mergers and Acquisitions- Organizational objectives- functions- relationships- organizational structure of formal organizations-Talent Management process- Manpower planning- Man power forecasting process and techniques- Job analysis and job design-Job description and job specification- Job enrichment, job enlargement and job rotation.

Recruitment and Selection**:** Developing sources, methods of recruitment, selection processes - psychometrics, assessment centres, social media for selection, recruitment yield pyramid, job offer, onboarding, orientation Training**:** The nature of training, objectives in training, types of

training, requirements of effective training conventional training techniques, management development, evaluating training effectiveness, training in a virtual environment. Performance management & appraisal: Philosophy of employee performance management, Traditional and contemporaryperformance appraisal systems, high performance work system.

Compensation and Benefits: Principles of employee compensation- Managing Basic Remuneration and Incentive-, Factors affecting compensation policy - Equity and compensation - Comparable value- Job evaluation- Cost to the company- Financial and Non-financial Employee Benefits- Career Management- Empowering Employees, Promotions- Basis of Promotions- Transfers- Separations and Rightsizing- Attrition Analysis-Retention Employee Relation:- Industrial Relations in India- Labour Laws and Labour Codes- Employee Engagement- Employee Health and Safety- Mental health, Employee Assistance Programme,-Empowering Employees- International HRM- Future of HRM.

References:

1. Dessler G and Varkkey, B, *Human Resource Management*, Pearson, 16th Edition, 2018
2. K. Aswathappa, *Human Resource Management*, Tata McGraw Hill, 2008.
3. Durai, Pravin. *Human Resource Management*. Pearson, 2010
4. Bernardin, John H. *Human Resource Management*.Mc-Grawhill,2012
5. Richard I. Henderson. *Compensation Management in a Knowledge Based World*. Pearson, 2006

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