Scheme of Instruction, Evaluation

and

Syllabi of

M.E. (CIVIL)

With specialization in

WATER RESOURCES ENGINEERING

Regular & CEEP

With effect from Academic Year 2026-27

Estd. 1917

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

Estd. 1929

INSTITUTION

The University College of Engineering was established in the prestigious Osmania University, Hyderabad in the year 1929 having the distinction of being the 6th oldest Engineering College in the then British India. The college become autonomous in the year 1994. Over the decades, the UCE(A), OU has produced several illustrious alumni who brought laurels to the nation at world forums. The college is offering BE in eight branches viz., AI&ML, BME, CE, CSE, EEE, ECE, ME and Mining Engineering; ME in 22 specialisations with majority of them receiving NBA Accreditation. The college offers Ph.D. in all ME specialisations. The college has well established laboratories and research facilities and is well placed in NIRF Rankings. The faculty members are well qualified and several of them received Best Teacher Award from Government of Telangana state. They are serving as expert members on several professional bodies, state and national level committees. The faculty members authored several research publications, text/reference books and extend consultancy services.

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

The Department of Civil Engineering was established in the year 1929 and was the first Department to commence the undergraduate programme at University college of Engineering, Osmania University. Over the years, the Department grew from strength to strength in terms of its academic achievements and infrastructure development. The Department has produced many All India GATE 1st Rankers / Toppers in Indian Civil Services / IES / State Public Service Commission Tests and those who got admitted in to IITs/IISc./Top Universities in the world for higher studies. The renowned alumni of this Department include several successful Engineers in Government Departments / Consultants / Contractors / Academicians who made positive contribution to the development of State and Nation.

Currently, the Department offers BE in Civil Engineering; ME in Structural Engineering,

Geotechnical Engineering, Water Resources Engineering and Transportation Engineering specializations and Ph.D. programs. The Department also has the distinction of enrolling large number of foreign students both at UG and PG level. The Department provides research and consultancy services to various organizations. Several faculty members have received prestigious awards including the Best Teacher awards of the State Government and the Best Publication awards reflecting high standards in teaching and research. Many of the faculty members are listed in several national and international biographical directories. Many of them are serving in Panel of Experts in the State and National level committees. The faculty members have published over 1500 papers in various international and national journals and conferences besides text books and professional books.

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To produce highly competent and capable professionals to face the challenges and provide viable solutions to Civil Engineering problems
- Integration of their knowledge and skills to excel in the profession through continuous learning and contribute to the well being of the society.
- To enhance the technical knowledge, research aptitude to serve the society in highly competent manner.

Programme Educational Objectives (PEO):

PEO 1: Impart and enrich knowledge in the fields of Surface and Groundwater Engineering

PEO 2: Exposure to the state-of-art techniques and/or knowledge of modeling techniques in to be adopted for different Water Resources Engineering problems

PEO 3: Facilitate the policy makers and administrators to solve issues pertaining to regional Water Resources and Environmental Engineering

PEO 4: Provide continuing education as per the needs of practicing engineers and academician to enhance their technical knowledge

PROGRAM OUTCOMES (POs)

PO-1	Acquaintance with the principles of water Resources Engineering
PO-2	Familiarity with the Planning, Design, and modeling techniques of Water Resources and Environmental Engineering Systems to solve real life problems
PO-3	Advocate the practicing Engineers and Academicians to enhance their technical knowledge so as to device effective policies
PO-4	Proficiency to carry out research /investigation for the sustainable development of water resources
PO-5	Capability to write and present a technical report /document independently
PO-6	Ability to exhibit professional, ethical and managerial skills.

Course outcome	Program Outcome					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
PEO 1	3	2	1	1		
PEO 2	2	1	2	2	1	1
PEO 3	1	2	3	1	1	2
PEO 4	2	2	1	2	2	2
Average	**2**	**1.75**	**1.75**	**1.5**	**1.33**	**1.67**

TABLE-I

Scheme of Instruction and Evaluation for M.E./M.Tech. Programmes (Regular)

w.e.f. 2026-27

S. No.	Course Code	Course Name	Contact hours per week		Scheme of Examination		Credits
			L	P	CIE	SEE	
		SEMESTER-I					
1.		Core-I	3	---	40	60	3
2.		Core-II	3	---	40	60	3
3.		Core-III	3		40	60	3
4.		Programme Elective-I	3	---	40	60	3
5.		Programme Elective-II	3	---	40	60	3
6.		Programme Elective-III	3	---	40	60	3
7.		Laboratory-I	0	2	50	-	1
8.		Seminar	0	2	50	-	1
		TOTAL	**18**	**4**	**340**	**360**	**20**
		SEMESTER-II					
1.		Core-IV	3	---	40	60	3
2.		Core-V	3	---	40	60	3
3.		Core-VI	3	---	40	60	3
4.		Programme Elective-IV	3	---	40	60	3
5.		Programme Elective-IV	3	---	40	60	3
6.		Open Elective	3	---	40	60	3
7.		Mini Project	---	4	50	---	2
8.		Laboratory-II	---	2	50	---	1
9.		Laboratory-III	---	2	50	---	1
		TOTAL	**18**	**8**	**390**	**360**	**22**
		SEMESTER-III					
1.		Audit Course-I (Online)	2	---	40	60	0
2.		Audit Course-II (Online)	2	---	40	60	0
3.		Dissertation-I	---	20*	100	---	10
		TOTAL	**4**	**20**	**180**	**120**	**10**
		SEMESTER-IV					
1.		Dissertation-II	---	32*	100	100	16
		GRAND TOTAL	**40**	**64**	**1010**	**940**	**68**

Note:

i. Dissertation-II has two parts, CIE - I and CIE - II, at the end of 8th week and 16th week respectively for evaluation for each of 50 marks.

ii. Audit Course will be offered in ONLINE/OFFLINE/HYBRID mode and SEE will be conducted in Computer Based Test Mode.

iii. Research Methodology and IPR will be offered as an Audit Course for all PG Programs.

iv. Engineering Research Methodology workshop will be conducted for one week to the Ph.D scholars.

***The student has to work a minimum of 20 hours/week and 32 hours/week at Dissertation - I and II.**

TABLE-II

M.E./M.Tech. Six Semester (CEEP) Program Scheme of Instruction and Evaluation

S.No.	Course Name	Contact hours per week		Scheme of Examination		Credits
		L	P	CIE	SEE	
	SEMESTER-I					
1.	Core-I	3	---	40	60	3
2.	Core-V/Program Elective-II	3	---	40	60	3
3.	Program Elective-I	3	---	40	60	3
4.	Laboratory-I	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-II					
1.	Core-II	3	---	40	60	3
2.	Core-V Program Elective-II	3	---	40	60	3
3.	Program Elective-III	3	---	40	**60**	3
4.	Seminar	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-III					
1.	Core-III	3	---	40	60	3
2.	Core-VI Program Elective-IV	3	---	40	60	3
3.	Program Elective-V	3	---	40	60	3
4.	Laboratory-II	---	2	50	---	1
	TOTAL	**9**	**2**	**170**	**180**	**10**
	SEMESTER-IV					
1.	Core-IV	3	---	40	60	3
2.	Core-VI Program Elective-IV	3	---	40	60	3
3.	Open Elective	3	---	40	**60**	3
4.	Mini Project	---	4	50	---	2
5.	Laboratory-III	---	2	50	---	1
	TOTAL	**9**	**6**	**220**	**180**	**12**
	SEMESTER-V					
1.	Audit Course-I	2	---	40	60	0
2.	Audit Course-II	2	---	40	60	0
3.	Dissertation-I	---	20*	100	---	10
	TOTAL	**6**	**20**	**180**	**120**	**10**
	SEMESTER-VI					
1.	Dissertation-II	0	32*	100	100	**16**
	GRAND TOTAL	**42**	**64**	**1010**	**940**	**68**

Note:

i. Dissertation-II has two parts, CIE - I and CIE - II, at the end of 8th week and 16th week respectively for evaluation of 50 marks each.

ii. Audit Course will be offered in ONLINE mode and SEE will be conducted in Computer Based Test Mode.

iii. Research Methodology and IPR will be offered as an Audit Course for all PG Progrms.

iv. Engineering Research Methodology workshop will be conducted for one week to the Ph.D scholars.

***The student has to work a minimum of 20 hours/week and 32 hours/week at Dissertation – I and II.**

TABLE 1
DEPARTMENT OF CIVIL ENGINEERING, U.C.E., O.U
M. E. CIVIL (WATER RESOURCES ENGINEERING) (Regular)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	CE201	Advanced Hydrology	3			40	60	3
Core-II	CE202	Advanced Fluid Mechanics	3			40	60	3
Core-III	CE203	Integrated Watershed Management	3			40	60	3
Program Elective-I	CE211	Irrigation and Drainage Engineering	3			40	60	3
	CE212	Environmental Impact Assessment						
	CE213	Sediment Transport						
Program Elective-II	CE214	Impact of Climate changes in Water Resources Engineering	3			40	60	3
	CE215	Environmental Hydraulics						
	CE216	Stochastic Hydrology						
Program Elective-III	CE217	Water Resources Systems Planning	3			40	60	3
	CE218	Computational Methods in Fluid Mechanics						
	CE219	Wastewater Treatment Systems						
Mandatory	M251	Water Resources Engineering Lab	0		2	50		1
Mandatory	M261	Seminar	0		2	50	-	1
TOTAL			**18**		**4**	**340**	**360**	**20**
SEMESTER-II								
Core-IV	C204	Groundwater Engineering	3			40	60	3
Core-V	C205	Free Surface Flows	3			40	60	3
Core-VI	C206	Applied Statistics in Water Resources Engineering	3			40	60	3
Program Elective-IV	CE220	Hydraulic Structures	3			40	60	3
	CE221	Water Power Engineering						
	CE222	Flood Control and Management						
Program Elective-V	CE223	Geo Spatial Applications in Water Resources Engineering	3			40	60	3
	CE224	Groundwater contamination: Transport and Remediation						
	CE225	Models of Air and Water Quality						
Open Elective	OE 941 BM	Medical Assistive Devices						
	OE 942 BM	Medical Imaging Techniques						
	OE 941 CE	Green Building Technology						
	OE 942 CE	Cost Management of						

		Engineering Projects	3			40	60	3
	OE941 CS	Business Analytics						
	OE 941 EC	Elements of Embedded Systems						
	OE 941 EE	Waste to Energy						
	OE 942 EE	Power Plant Control & Instrumentation						
	OE 941 ME	Operational Research						
	OE 942 ME	Composite Materials						
	OE 943 ME	Industrial Safety						
	OE 941 LA	Intellectual Property Rights						
MC	MC271	Mini Project			4	50		2
Mandatory	M1252	Geographical Information Systems Lab	0		2	50	-	1
Mandatory	M1253	Computational Fluid Dynamics Lab	0		2	50	-	1
TOTAL			**18**		**8**	**390**	**360**	**22**
SEMESTER-III								
Audit -I	AC030	Engineering Research Methodology	2			40	60	0
Audit-II	AC 031	English for Research Paper Writing	2			40	60	0
	AC 032	Disaster Mitigation & Management						
	AC 033	Sanskrit for Technical Education						
	AC 034	Value Education						
	AC 035	Stress Management by Yoga						
	AC 036	Personality Development						
	AC 037	Constitution of India						
	AC 038	Pedagogy						
MC	CE281	Major Project- Phase -I	V		20	100		10
TOTAL			**4**		**20**	**180**	**120**	**10**
SEMESTER-IV								
MC	CE282	Major Project- Phase-II			32	100	100	16
GRAND TOTAL					64			**68**

CIE : Continuous Internal Evaluation **SEE : Semester End Examination**

SEMESTER-I

CE 201	ADVANCED HYDROLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Overview of meteorological and hydrologic factors.
2	Rainfall-runoff analysis by different methods.
3	Estimation of design flood, uncertainty, reliability and risk analysis.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Principles of physical processes in the context of hydrology, including the hydrological cycle in general.
CO-2	Comprehensive understanding of issues pertaining to rainfall, runoff and hydrograph analysis.
CO-3	Application techniques, such as flood frequency analysis, probabilistic methods to estimate design peak flows
CO-4	Ability to formulate rainfall-runoff models and its correlation and goodness of fit.
CO-5	Concepts on reliability, uncertainty and involved risks with an objective to optimize the benefits.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	-	-	2	3	-
CO-2	-	2	1	1	1	-
CO-3	-	1	1	1	1	-
CO-4	-	2	1	1	1	-
CO-5		-	1	1	1	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Evapotranspiration: Process of evaporation, factors affecting evaporation, measurement of evaporation, estimation of evaporation, evaporation reduction techniques

Infiltration: Introduction, factors affecting infiltration, measurement of infiltration (ring infiltrometers only), Infiltration indices (ϕ, w, and w_{min}).

UNIT - II
Runoff **:** Process, factors affecting runoff, rational formula for relation between precipitation and runoff, hydrograph analysis, unit hydrograph, instantaneous unit hydrograph. Synthetic unit hydrograph and Nash model.

UNIT - III
Statistics in Hydrology: Random variables, probability of hydrologic events, probability (Gumbel, Log-Pearson type-III distribution) and statistical methods for flood frequency, trend analysis for hydrologic events.

UNIT - IV
*Regression Analysis***:** Identification of appropriate models, parameters estimation by the least square method, measures of goodness fit, uncertainity features of LS based model parameters, statistical Inferences of Regression Coefficients, confidence Interval. Multivariate linear regression and correlation.
Topics to be taught by Industry Subject Expert :

UNIT - V
Reliability in Engineering: Brief theory of engineering reliability analysis – Definitions of Reliability and risk measures of reliability. Uncertainty in Engineering: Definition of uncertainty, types of Sources of uncertainty, analysis of errors, analysis of uncertainty. Risk analysis and management: Classification of risks, sources of risk, estimation of risk. Reservoir economics and optimization of benefits.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Ven Te Chow, '*Hand book of Applied Hydrology'* McGraw-Hill Book Company, New York., 1964
2	Subramanya, K. '*Hydrology for Engineers'*, Tata McGraw-Hill Publishing Company, New Delhi. (1984)
3	Raghnath, H. M. '*Hydrology'*, New Age International Pvt. Ltd., New Delhi. 1985
4	Gupta, R.S. '*Hydrology and Hydraulic systems*', Prentice Hall of India, New Delhi.1989
5	Yeou Koung Tung, Benchie Yen, Charles Staven Melching , '*Hydro systems*

	Engineering Reliability Assessment and Risk Analysis', McGraw-Hill Book Company, New Delhi. 2005

CE 202	**ADVANCED FLUID MECHANICS**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to the governing equations of fluid motion
2	Knowledge about grid generation and boundary conditions
3	Description of ideal fluid flow theory and its application in real life problems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Acquaintance with application of Navier-Stokes equations
CO-2	Comprehensive understanding regarding the concepts of boundary layer theory
CO-3	Knowledge of turbulent boundary layer governing equations
CO-4	Ability to analyse turbulence models for the solution of fluid flow problems
CO-5	Application of ideal fluid flow theory concepts to water resources engineering problems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	3	2	2	1	
CO-2	3	3	2	2	1	
CO-3	3	3	2	2	1	
CO-4	2	3	2	2	1	
CO-5	2	3	2	2	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Dynamics of Flow: Continuity equation, equations of motion, and Navier-Stokes equations, simple exact solutions to NS equations (steady laminar flow between parallel plates and in a circular tube of constant diameter).

UNIT - II
Boundary layer flows: Concept of boundary layer, Prandtl's boundary layer equations, Von Karnan-Pohlhausen integral momentum equation, Blasius solution for laminar boundary layer flow over a flat plate, boundary layer separation.

UNIT - III
Turbulent Boundary layer: Sources of turbulence, velocities, energies and continuity in turbulence, turbulent shear stresses, Reynolds equations for incompressible fluids, Prandtl's mixing length theory in shear flows, law of wall, velocity defect law, velocity distribution in turbulent flow through smooth and rough pipes.
Governing Equations: Classification of Partial Differential Equations (PDE), Reynolds Averaged Navier-Stokes equation

UNIT - IV
Classical turbulence models: Mixing length model, k-ε model, and Reynolds Stress equation model Solution procedure, Grid generation and grid independence, and Boundary conditions.
Computational Fluid Dynamics: Finite Volume formulation for diffusion equation, Convective-Diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE & PISO algorithm.
Topics to be taught by Industry Subject Expert :

UNIT - V
Standard Patterns of flow: Source, sink, vortex pair, spiral vortex, flow past a half body, flow past a Rankine body, flow past a cylinder with and without circulation
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Schlichting Herman and Klaus Gersten, 'Boundary Layer Theory', Springer (India) Pvt Ltd., New Delhi, 2007
2	Yunus A Cengel and John M Cimbala, *'Fluid mechanics: Fundamentals and Applications'*, Tata McGraw-Hill Publishing Company, New Delhi, 2008
3	Som, S. K. and Biswas, G., *'Fluid Mechanics and Fluid Machines'*, Tata McGraw-Hill Publishing Company, New Delhi, 1998.
4	Vijay Gupta and Santosh K. Gupta, *'Fluid Mechanics and its applications'*, Wiley Eastern Ltd., New Delhi,1984
5	Versteeg, H and W. Malalasekra, *'An Introduction to Computational Fluid Dynamics: The Finite Volume Method',* Pearson Education Ltd, Essex, England, 2007
6	Anderson John D. Jr., *'Computational Fluid Dynamics – The basics with applications'*, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2012

CE 203	INTEGRATED WATERSHED MANAGEMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concept of watershed management practices globally.
2	Acquaint with various features and issues of watershed management.
3	Create awareness about current status and importance of watershed management.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding the fundamentals of watershed Management practices.
CO-2	Ability to apply integrated watershed principles and asses the geomorphological characteristics of a watershed.
CO-3	Ability to model soil erosion, applying soil erosion control measures in a watershed and suggesting suitable methods for rain water harvesting structures.
CO-4	Adopting appropriate techniques applicable in urban water sensitive designs.
CO-5	Ability to solve problems related to environmental, socio-economical, water governance for sustainable watershed management.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	2	-	-	2	1
CO-2	3	3	-	2	2	1
CO-3	3	3	1	3	3	2
CO-4	2	3	1	2	1	1
CO-5	2	2	1	1	2	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Fundamentals of Watershed: Definition and concept of watershed development, objectives of watershed management; need for watershed planning in India. Socio-economic aspects of watershed management, impacts of changing demography and land use & land cover on watersheds management. Case studies on “on-site and Off-site” impacts of watershed

development.
Status of Water Resources in India: National and regional attributes of annual rainfall, evaporation rates, groundwater recharge, and surface runoff. Indian river basins and their water resources. Storage of surface water versus river discharge. Per capita availability of freshwater resources in India. Dark Zones and water crisis. Inter-linking of rivers, Ecological flow in the rivers. Water disputes in India.

UNIT - II
Integrated watershed management: Basics of Integrated watershed management; multidisciplinary approach for watershed management, Integrated watershed management programme in India.
Characteristics of Watershed: Size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.

UNIT - III
Dynamics of Soil Erosion: Types and formation of soils. Types of soil erosion, factors affecting erosion, effects of ploughing on soil erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, various universal soil loss equations. *Measures to Control Soil Erosion:* Need and importance of soil conservation. Contour techniques, furrowing trenching, building terracing, gully control, rock fill dams, brushwood dams, gabions, check dams, afforestation and agro-forestry.
Measures to Control Soil Erosion: Need and importance of soil conservation. Contour techniques, furrowing trenching, building terracing, gully control, rock fill dams, brushwood dams, gabions, check dams, afforestation and agro-forestry.

UNIT - IV
Urban Watershed Management: Urbanization and water requirement, per-capita availability of water in Indian cities, source of water and consumption patterns. Urbanization impacts on water balances. Municipal Sewage generation, recycling and re-use of grey water in global and Indian cities.
Water Sensitive Urban Design: Water-stress in cities, urban floods, urban storm-water drainage network, urban rainwater harvesting-systems and planning. Dessign constructions and applications green storm water Infrastructure such as rain-gardens, pervious concrete and green roofs. Low Impact developments, Best management practices. Climate change impacts on urban urbanizations, climate resilient water sensitive urban designs and urban flood modeling.

Topics to be taught by Industry Subject Expert :

UNIT - V
Sustainable Watershed Management: Concept of sustainability and sustainable developments; Need of water conservation. Indigenous practices in watershed management. Need of social awareness. Importance of people's participation in water conservation measures and watershed management.
Water Quality: Concept, Characterization and assessment, water quality issues in surface and groundwater bodies, monitoring and analysis protocol. Status of water quality in Indian rivers and lakes. Approaches to minimize the impacts of anthropogenic contaminates on water resources. Socio-economic and environmental cost of water quality degradation
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Das, M. M. and Saikia,M.D. *"Watershed Management"*, PHI Learning Pvt. Ltd, India, 2013
2	Gonenc, I. E., Wolflin, J. P., & Russo, R. C. (Eds.). *Sustainable Watershed Management*. CRC Press. 2014
3	Jain, S. K., Agarwal, P. K., & Singh, V. P. *Hydrology and water resources of India (Vol. 57)*. Springer Science & Business Media. 2007
4	Krenkel, P. *Water quality management*. Elsevier. 2012
5	Larry W.Mays. "*Integrated Urban Water Management: Arid and Semi-Arid Regions*". CRC Press, Taylor & Francis Group, Netherlands. 2009
6	Majumdar D.K. *"Irrigation and Water Management."* Prentice-Hall of India, New Delhi. 2000
7	Morgan, R. P. C. *"Soil erosion and conservation."* John Wiley & Sons. 2009

Program Elective I

CE 211	IRRIGATION & DRAINAGE ENGINEERING					
Pre-requisites	Knowledge of soil classification, Evaporation,Transpiration, groundwater parameters, etc., in UG Programme		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to concepts and behavior of soil-water-plant relationship
2	Exposure to various water application techniques and their design principles
3	Awareness relating to the drainage equations and its applications

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Comprehensive understanding about soil-water plant relationships
CO-2	Knowledge of different methods of Evapotranspiration
CO-3	Skill for the choice and design of suitable water application method
CO-4	Perceptive awareness regarding principles of drainage for sub surface flows
CO-5	Application of principles of drainage for various flow scenarios for the sustainable development of the society

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	2	1	3	1	
CO-2	1	2	2	3	1	
CO-3	1	2	2	2	1	1
CO-4	1	2	2	2		
CO-5	1	1	2	1	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Soil Agronomy – Soil moisture retention and movement, soil moisture tension, soil moisture stress, soil moisture constants (saturation capacity, field capacity, permanent witting point and available water), Measurement of soil moisture (Gravimetric, tensiometer, pressure membrane, electrical resistance and Neutron moisture meter methods), Soil-water-plant relationships, soil – water relationships, Soil – Crop relationships and fertility of soil.

UNIT - II
Estimation of evapotranspiration from direct and indirect/climatologically data using Blaney–Criddle, Thronthwaite, Penman, Modified Penman Method, Hargreaves Radiation methods.

UNIT - III
Water Application methods – Details and design specifications for Border, Check basin, Furrow, sprinkler, and drip methods of applications of water. Irrigation requirements: gross, net, and frequency of application, Irrigation efficiencies.

UNIT - IV
Basics of Groundwater flow- Dupuit - Forchheimer's assumptions, water table subjected to recharge or capillary rise, steady flow towards a well, steady state drainage equations (Hooghoudt, and Ernst) and its applications, unsteady state drainage equations (Glover-Dumm, De Zeeuw-Hellinga Equation) and its applications
Topics to be taught by Industry Subject Expert:

UNIT - V
Drainage criteria- Water table indices for drainage design, steady state versus unsteady state drainage equations, critical duration, storage capacity, and drainage design. *Drain spacings:* Principles of Hooghoudt, and Ernst equations.
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Michael, A.M., *'Irrigation Theory & Practice, 2/e',* Vikas Publishing House, New Delhi, 2010
2	Peter Waller, Muluneh Yitayew, *'Irrigation and Drainage Engineering'* 1st Edition, Springer Nature, 2016
3	Ritzema, H.P., *'Drainage Principles and Applications'*, International Institute for Land Reclamation and Improvement, Publication no.16 (second edition), Netherlands, 1994 (www.ilri.nl)
4	Beers Van W.F.J., *'Computing Drain Spacings'*, International Institute for Land Reclamation and Improvement, Bulletin no.15, Netherlands 1976 (www.ilri.nl)

CE 212	ENVIRONMENTAL IMPACT ASSESSMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction of EIA concepts and methodologies.
2	Importance of data collection of EIA assessment.
3	Preparation of EIA reports and discussion about various environmental impact Laws pertaining to India.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge to assess environmental Inventory and principles.
CO-2	Understanding legislative acts to contribute towards clean environment
CO-3	Applying the legislation acts of EIA in designs.
CO-4	Understanding various characteristics of municipal solid waste.
CO-5	Design of an efficient municipal solid waste management system

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	2	1		1	1
CO-2	1	2	1	1	1	1
CO-3	1	2	1	1	1	1
CO-4	1	2	1		1	1
CO-5	1	1	2		1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Enviornmental Impact Assessment: Definition, basic concepts and principles of EIA. Regulatory frame work in India. Enviornmental inventory, base line studies, over view of EIA studies

UNIT - II
Assessment and Methodologies: Physical, biological assessment, Socio economic and cultural enviornmental assessment, EIA methodologies–Adhoc, matrix, checklist approaches. Economic evaluation of impacts-cot benefits of EIA, Public participation in environmental decision making. Procedures for reviewing EIA analysis and statement.

UNIT - III
Environmental Assessment: Introduction, process, Basic steps involved, Description of environmental setting – Base line data collection, possible impacts due to water resources projects. Impact prediction and assessment – methods of impact assessment, Matrix and check list method, Selection of proposed action. Preparation of environmental impact statement.

UNIT - IV
Environmental Legislation and Regulations: Rationale, concerns, legislative data systems, safe drinking water act, clean water act, clean air act, noise control act, resource conservation and recovery act, comprehensive environmental response, compensation and liability act.
Topics to be taught by Industry Subject Expert :

UNIT - V
Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal).
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Canter, L.W. '*Environmental Impact Assessment'*, McGraw-Hill Book Company, New York. 1996
2	Corbitt Robert A. *Standard Hand Book of Environmental Engineering'* McGraw-Hill Book Company, New York. 1999
3	Marriott '*Environmental Impact Assessment*: A Practical Guide', McGraw-Hill Book Company, New York. 2005

CE213	ENVIRONMENTAL IMPACT ASSESSMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the sediment and fluvial Hydraulics concepts
2	Discussion of sediment transport mechanism and regimes of flow
3	Introduction of Alluvial streams, reservoir siltation, sediment control and bank protection.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge of properties of sediments and sediment problems
CO-2	Ability to understand sediment transport mechanism
CO-3	Ability to collect the sediment using sediment samplers and design of stable channels
CO-4	Analysis of various stages of streams including stream characteristics
CO-5	Assessment of scour and ability to plan sediment controlling methods and protection.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	2	2	1		
CO-2	3	2	1	1		
CO-3	3	2	1	1		
CO-4	2	2	1	1		
CO-5	2	2	1	1		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction: Sediment and Fluvial Hydraulics –nature of sediment problem- origin and formulation of sediment – fundamental properties of individual sedimentary particles-bulk property of sediments.

UNIT - II
Sediment Transport: Incipient motion of sediment particles- regimes of flow, resistance to flow and velocity distribution in alluvial stream-bed load transport suspended load transport-total load transport

UNIT - III
Sediment samplers and sampling, bed load sampling—suspended load sampling - Design of Stable channels: variables in channel design, design of channels by permissible velocity method and tractive force method.

UNIT - IV
Alluvial streams: Introduction, various stages of streams, stream slope, stages of streams, stream slope, shapes of streams, bed level variations in alluvial streams, continuity equation for sediment, stream bed changes during floods.
Topics to be taught by Industry Subject Expert :

UNIT - V
Sediment Control: Silting of reservoirs, local scour , sediment control in canals, Methods actions, in controlling methods , objections of river training, and bank protection .
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Graf, W.H. " *Hydraulics of Sediment Transport* " Mc Graw Hill Company, New York, 1971
2	Garde RJ and Ranga Raju KG, *Mechanics of Sediment transportation and alluvial stream peoblems*, Wiley Easterns Ltd, New Delhi, 1995.
3	Yalin MS, *Mechanics of Sediment transport*, Pergaman Press, Oxford, 1997.

Program Elective II

CE 214	**IMPACT OF CLIMATE CHANGE ON WATER RESOURCES ~~ENGINEERING~~**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to basic concepts of General Circulation Models and their importance.
2	Features of Indian summer monsoon rainfall (ISMR) and their characteristics
3	Downscaling principles of statistical downscaling and dynamical downscaling.
4	
5	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of various components of Climate System.
CO-2	Comprehensive Understanding of Hydrological cycle, water balance, distribution of precipitation
CO-3	Ability to comprehend the monsoon wind patterns, ISMR characteristics, floods and droughts.
CO-4	Analysis and synthesis on the causes of climate change on hydrology using General Circulation Models (GCMs)
CO-5	Modeling of climate variables using various downscaling approaches and Applications of Hydrologic models

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	2	1	2	1	1
CO-2	2	2	1	2	1	-
CO-3	2	2	1	2	1	-
CO-4	1	2	2	2	1	1
CO-5	2	2	1	2	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Climate System- Weather and Climate- Overview of earth-atmosphere- vertical structure of atmosphere- Radiation and Temperature- Temperature variation- vertical variation in Air temperature- temperature extremes

UNIT - II
Hydrological cycle- Introduction- Global water balance- cycling of water on land- simple water balance- climate variables affecting precipitation- forms and types of precipitation.

UNIT - III
Monsoon- wind patterns in India- Global wind circulation- clouds- Types of clouds-Indian summer monsoon Rainfall (ISMR) - characteristics- climate variability- Floods- droughts- drought Indicators - climate extremes.

UNIT - IV
Causes of climate change - Modeling of climate change-General circulation models (GCMs) –IPCC scenarios - IPCC Assessment Report (AR5) - Physical Science basis.
Topics to be taught by Industry Subject Expert :

UNIT - V
Bias correction methods -Downscaling – Types of downscaling- Dynamical downscaling- Regional Climate Models - statistical downscaling - Types of statistical downscaling - climate predictors - data reduction techniques -principal component analysis- step wise regression- Lasso- - Kernel Regression - SDSM software - Hydrology models - Introduction on Soil and water assessment tool SWAT and VIC (variable Infiltration capacity models)
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Bonon G B - *Ecological climatology*- Cambridge University Press Edition- II - ISBN-1107268869, 2008
2	RL Wilby, SP charles, E Zoritaa, B Timbal, P WHetton, LO Mearns - *Guide lines for use of climate science from Statistical Modeling models*. 2004
3	*Physical science basis of AR 5 report of IPCC - working group I contribution to Assessment Report*- https://ipcc.ch/report/ar5/wg1/ 2021
4	*Soil and Water Assessment Tool SWAT- user Manual Report (2005) http://swat.tamu.edu/media/1294/swatuserman.pdf* 2005
5	*VIC model Macro scale Hydrologic Model- http://www.hydro.washington.edu/Lettenmaier/Models/VIC/index.shtml*
6	Rasmus E Benestad, Inger Hanson Baver, Delinag Chen (2008) *Empirical Downscaling* World Scientific Publishing Co. Ltd. 2008.
7	Haan T. C., Statistical Methods in Hydrology, East West Publishers, 1998

CE 215	ENVIRONMENTAL HYDRAULICS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to basic principles of Fluid Mechanics
2	Exposure to hydraulic pipes, their design philosophy
3	familiarity of advection and dispersion equations and Mass transfer in gas-liquid and liquid -liquid system
4	
5	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to apply concepts of Fluid mechanics in various fields of water resources.
CO-2	Application of hydraulics principles in the design of pipes.
CO-3	Modelling of mixing processes and application of advection and dispersion equations.
CO-4	Understanding of mixing and density stratified flows
CO-5	Ability to analyse Mass transfer in gas-liquid and liquid -liquid systems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	2		2	2	
CO-2	2	2		2	1	1
CO-3	2	2	1	2		-
CO-4	1	2	2	2		1
CO-5	2	2	1	2		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction and scope, review of basic principles of engineering fluid mechanics, continuity, momentum, and energy equations, steady flow through pipes- hydraulic gradient and total energy line, basics of open channel flow; Ground water, well hydraulics, well design and constructions,

UNIT - II
Basic equations for fluid flow analyses including Reynolds transport theorem- Parallel, compound and equivalent pipes, head losses in pipes, design of pressurized conduits- General design requirements – Methods of analyses – Control of water hammer in long distance transmission. – Introduction to optimization of water distribution system.

UNIT - III
Various forms of mixing in the environment, modeling of the mixing process. advection dispersion equation, Various forms of advection dispersion eq. and its solution.

UNIT - IV
Models for rivers and streams - Completely mixed and incompletely mixed systems. BOD and oxygen saturation, Streeter-Phelps equation, point and distributed sources- Special cases of mixing, density stratified flow, tide, etc.
Topics to be taught by Industry Subject Expert :

UNIT - V
Mass transfer in gas-liquid and liquid -liquid system with special emphasis on aeration, Project presentation
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Roberson, J.A., Cassidy, J.J., Chaudhry, M.H. "*Hydraulic Engineering*", 2nd Edition, Wiley. 1998
2	Chadwick, A., Morfett, J., Borthwick, M. "*Hydraulics in Civil and Environmental Engineering"*, 5th Edition, CRC Press. 2004
3	Lee, C. C., Lin, S.D. "*Handbook of Environmental Engineering Calculations*", McGraw Hill. 2007

CE 216	STOCHASTIC HYDROLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Description of the concepts of deterministic and Stochastic hydrology
2	Exposure to the principles of basic statistical hypothesis testing, KS test
3	Concepts of linear regression and time series analysis

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Capable of finding parameters estimation, fitting of probability distributions, methods of moments.
CO-2	Able to Perform frequency analysis of hydrologic extremes and uncertainty
CO-3	Able to execute simple linear regression and multiple regression
CO-4	Ability to accomplish Cluster analysis and modelling of hydrologic time series
CO-5	Able to model Markov process and understanding of Copula in Hydrology.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1		2	1	2	2	
CO-2	1	2	1	2	1	1
CO-3	1	2	1	2		-
CO-4	1	2	2	2		1
CO-5	1	2	1	2		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Deterministic and Stochastic Hydrology, review of concepts of probability, probability axioms, Random variables and their properties, probability distribution and probability density function, Discrete and continuous probability distributions used in hydrology, moments and expectations of distributions, Parameter estimation, method of moments, maximum likelihood method ,

UNIT - II
Hypothesis testing, goodness test of fit tests, Chi Square test and KS test, Analysis of hydrologic extremes, Frequency analysis of extreme events, extreme value distributions, analysis of floods, droughts and other natural hazards, Regional flood frequency analysis-Transformations, Modelling hydrologic uncertainty

UNIT - III
Correlation analysis and correlation coefficient, Simple linear regression, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis, analysis of variance applications – rainfall-runoff analysis, rating curves.

UNIT - IV
Data generation techniques, stream flow forecasting, First order Markov process, Markov chain, Multi-site time series model, cross-correlation, spatial and temporal disaggregation models.
Topics to be taught by Industry Subject Expert :

UNIT - V
Theory of copula and its use in hydrology, commonly used copula functions, selection of best fit copula, uses of copula.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Kotteguda, N.T., Stochastic Water Resources Technology, The Macmillan Press, New York, 1982
2	Rajib Maity, Statistical Methods in Hydrology and Hydroclimatology, Springer Nature Singapore Pte Ltd., 2018
3	Haan T. C., Statistical Methods in Hydrology, East West Publishers, 1998
4	Kotteguda, N.T., and Resso, R., Statistics, Probability and Reliability for Civil and Environmental Engineers, Blackwell Publishing, UK, 2008
5	NPTEL Course on Stochastic Hydrology, http://nptel.ac.in/syllabus/105108079/

Program Elective III

CE 217	WATER RESOURCES SYSTEMS PLANNING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to various steps in water resources systems approach.
2	Economic decision making in water resources.
3	Identification of decision variables for linear and dynamic programming models and solution procedures for simple problems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to understand water resources systems concepts their stages and procedures.
CO-2	Application of Cash flow diagrams and solution to Water Resources problems based on economical aspects
CO-3	Ability to formulate WRE problems by L.P. and D.P models and solving simple problems.
CO-4	Ability to decide based on economic evaluation criteria for decision making of simple water Resources systems
CO-5	Ability to formulate L.P models for water Resources systems problems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	1	1	-	1	1
CO-2	2	1	2	-	1	1
CO-3	1	1	1	-	1	1
CO-4	2	1	1	-	-	1
CO-5	1	2	-	2	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction: Objectives of water resources development, plan formulation, planning models and solution procedures, basic steps involved in water resources systems approach, cash flow diagrams, annuities, discounting (Net Present Value, Internal Rate of Return, and Benefit

Cost Ratio), and non-discounting techniques (urgency, payback, and average rate of return), cost comparison, determination of project benefits, economic and financial analysis of projects.

UNIT - II
Water Resources Planning: Concept of Water Resources Planning, Categories of Water Use, Stages and Flow Activities, Relationship among stages, Data Collection and Processing, Estimation of Future Water Demands for Irrigation, Municipal Use, Industrial and Hydropower, Planning for Operation.

UNIT - III
Optimization techniques: Linear programming (introduction, geometrical approach and interpretation, basic concepts of simplex method), Dynamic Programming (basic concepts, general approach to recursive optimization, formulation of multistate problems), application to water resources engineering problems.

UNIT - IV
Stochastic optimization: Introduction to stochastic linear and stochastic dynamic programming, two stage linear programming, linear programming with chance constraints. *Simulation:* Basic concepts and application to water resources engineering problems.
Topics to be taught by Industry Subject Expert :

UNIT - V
River basin planning models: Irrigation planning model, resource inputs of irrigation, crop diversification, costs of inputs, formulation of linear programming models for single reservoir, multi reservoir cases with single and multiple objectives.
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Loucks, D. P., Stedinger, J. R., and Douglas, A.H. 'Water Resources Planning and Analysis', Prentice-Hall, New York. 1981
2	Kuiper Edward (1965), 'Water Resources Project Economics', Butterworths and Company Ltd., London.
3	Jain, S.K. and Singh V.P. '*Water Resources Systems Planning and Management*', Elsevier Science, B.V., Amsterdam. 2003

4	Taha, H. A. 'Operations Research an introduction', Prentice-Hall of Indial, New Delhi. 1982
5	Pramod. A. Bhave "*Water Resources Systems*" Narora Publishing House, 22, Medical Association Road, Dharyagunj, New Delhi, 2011
6	Vedula S and P P Mujumdar Water Resources Systems Modelling Techniques and Analysis , TMH Publishers, 2017

218	Computational Methods in Fluid Mechanics					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to various numerical techniques.
2	Introduction to FEM approach
3	Modelling of various water resources problems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to apply to numerical techniques such as method of characteristics, FDM to water resources problems
CO-2	Application of FEM techniques
CO-3	Applications modelling studies to problems such as of steady state flow and hydraulic transients flows
CO-4	Applications modelling studies to problems such as non-uniform , transient spatially varied flows
CO-5	Ability to use Numerical solutions for Navier-Stokes, boundary layer and Reynolds equations and modelling of groundwater flow and containment transport in groundwater.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	1	1	-	1	1
CO-2	2	1	2	-	1	1
CO-3	1	1	1	-	1	1
CO-4	2	1	1	-	-	1
CO-5	1	2	-	2	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Review of numerical techniques like method of characteristics, finite difference method - Basic aspects of Discretization, Finite Difference formulae for first order and second order terms , Space

Derivative Approximations Finite-Difference Operators Constructing Differencing Schemes of Any Order Fourier Error Analysis Difference Operators at Boundaries

UNIT - II
Finite element method - Approximation of Elliptic Problems Piecewise Polynomial Approximation A Posterior Error Analysis Evolution Problems

UNIT - III
Modelling of steady state flow and hydraulic transients in pipes.

UNIT - IV
Modelling of non-uniform, transient spatially varied flows in open channels.
Topics to be taught by Industry Subject Expert :

UNIT - V
Numerical solutions for Navier-Stokes, boundary layer and Reynolds equations and Modelling of groundwater flow and containment transport in groundwater.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Anderson, "Computational Fluid Mechanics and Heat Transfer", McGraw Hill. 1984
2	Chung, T. J., "Finite Element Analysis in Fluid Dynamics", McGraw Hill. 1978
3	Anderson, & Weessner, "Applied Groundwater Modelling", Academic Press. 1992
4	Chaudhary, H. M., "Applied Hydraulic Transient", McGraw Hill. 1976
5	Streeter and Wylie, "Fluid Transients", McGraw Hill. 1976

+

CE 219	WASTEWATER TREATMENT SYSTEMS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Description of different units of primary treatment and their relative importance
2	Illustration about various techniques of natural and mechanical systems of sewage disposal
3	Knowledge of disposal methods for conservation of water quality in lakes, rivers, and oceans

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Aptitude to plan for wastewater treatment facilities and conservation of ecological systems
CO-2	Skill for the selection of appropriate technologies for joint treatment of domestic and industrial wastewater
CO-3	Comprehend with the principles for the application of natural and mechanical systems of sewage disposal
CO-4	Talent for the choice and design of sludge treatment process and effluent disposal into rivers and oceans
CO-5	Knack the subject knowledge for sustainable development of society with ethics

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	3	1	1	1	
CO-2	2	3	2	1	1	
CO-3	2	2	1	1	1	
CO-4	2	2	1	1	1	
CO-5	1	2	1	2	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Planning in domestic wastewater treatment: Outline of unit processes, different types of treatment methods, primary treatment, screening, neutralization, equalization, flocculation, sedimentation, flotation, nitrification-dentitrification systems. Environmental impact and others considerations in planning treatment facilities.

UNIT - II
Joint treatment: General characteristics of industrial sewage, processes involved in the treatment of industrial sewage, self purification of streams for combined discharges of domestic and industrial wastes, joint treatment requirements, and ordinances.
Aerated Lagoons: Design of facultative aerated, aerobic flow through dual powered aerated and extended aeration lagoons.

UNIT - III
Waste stabilization ponds: Types of ponds, factors affecting pond eco-system, design of aerobic and anaerobic stabilization ponds- *Design of wastewater irrigation systems:* Rapid infiltration system, over land flow systems, and vermiculture.

UNIT - IV
Design of sludge treatment units: Sources, types of sludge, characteristics of sludge, weight-volume relationship, sludge treatment processes, selection criteria for sludge treatment processes, sludge drying beds, and sludge calculations.
Topics to be taught by Industry Subject Expert :

UNIT - V
Effluent Disposal: Receiving water standards, disposal into lakes, rivers, mathematics of mass transport, diffusion-advection, hydraulic models of physical systems. (continuous flow stirred tank, reactor model, and plug flow reactor model) disposal into the ocean, outfall design.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Metcalf and Eddy, *'Wastewater Engg; treatment, disposal reuse'*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995
2	Soli J Arceivala, *'Wastewater Ttreatment for pollution control'*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3	Kiely Gerard, *'Environmental Engineering'*, McGraw-Hill International Limited., London, 1998
4	Hammer, M.J. and Hammer, M.J. Jr., *'Water and Wastewater Technology'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998
5	Nemerow, Nelson Leonard, *'Theories and Practices of Industrial Waste treatment'*, Addison Wesley Publishing Company Inc., Massachusetts, 1963

CE 251	WATER RESOURCES ENGINEERING LABORATORY					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		50 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Conduct of Various Hydrological laboratory experiments in lab.
2	Conduct of various Hydraulics experiment in laboratory set up.
3	Introduction and writing programs in MATLAB Environment.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to perform experiments based on principles of Surface and Ground water Engineering (20 Marks)
CO-2	Ability to analyse, interpret and drawing inferences based on Experimental/Simulation/Coding Data (15 Marks)
CO-3	Capability to present technical/lab report and able to write programs & Applications of certain softwares to water resources Engg (15 Marks)

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	2	1	-		
CO-2	1	2		1		
CO-3					3	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

WATER RESOURCES LABORATORY

1	Measurement of infiltration rate of a soil
2	Measurement of Rainfall and Runoff for simple storm in model Basin
3	Measurement of Rainfall and Runoff for complex storm in model Basin
4	Effect on Runoff due to impermeable land use due to complex storm in model Basin
5	Verification of Sediment flow in Catch Basin due to Rainfall and Runoff
6	Simulation of storm flow in Catch Basin and development of Unit Hydrograph
7	Study of Scour pattern and measurement around piers of different shapes
8	Verification of Drawdown curve experiment in Groundwater Model
9	Verification of Drawdown impact due to interference of wells in Groundwater Model

MATLAB PROGRAMS

10	Regression Analysis
12	Unit Hydrograph
13	Fitting of probability distributions to the Data
14	Flood routing by Muskinghum method
15	Water Distribution Network using EPANET software
16	Climate change applications using SDSM software

CE261	SEMINAR					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-	-	1
Evaluation	**SEE**	-	**CIE**		50 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Problem definition
2	Literature survey, familiarity with research journals
3	Broad knowledge of the available techniques to solve the problem
4	Technical writing skills
5	Presentation skills

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify appropriate topic of relevance.
CO-2	Update literature on technical articles of selected topic and develop comprehension.
CO-3	Prepare a technical report and Deliver presentation on specified technical topic

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	--	2	--	--	1
CO-2	2	-	1	--	1	1
CO-3	2	--	2	3	2	--

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

The objective of the seminar is to prepare the student for a systematic and independent study of the state of art topics in his/her specialization. Seminar topics may be chosen by the students with the advice of the faculty members. Students are exposed to the following aspects:

Each student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

SEMESTER-II

CE 204	GROUNDWATER ENGINEERING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	A pathway to understand the basic physical principles of groundwater flow, differential equations, boundary condition and groundwater quality.
2	Knowledge of various aspects of recharge of groundwater.
3	Exposure to use the numerical solutions to solve problems with complex realistic situations.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge of groundwater hydrology and hydraulics of the movement of water in aquifers to manage groundwater resources.
CO-2	Comprehensive understanding of the issues pertaining to unsteady radial flows in aquifers.
CO-3	Analyze the results obtained from geophysical methods and use them to identify the zones for feasibility of groundwater recharge.
CO-4	Ability to deal with more realistic situations to solve problems pertaining to groundwater quality.
CO-5	Conduct simulation studies for future state of groundwater systems, optimal protection and rehabilitation strategies

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2		2	1		1
CO-2	1	2	1	2	1	
CO-3		1	2	3	1	
CO-4		2	2	2	1	
CO-5		1	1	3		1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction: Ground water in hydrologic cycle, Distribution of subsurface water, ground

water potential, occurrence of groundwater in hydro geologic formations, components of groundwater studies, Darcy's law and its validity. Governing equations of groundwater flow in aquifers: 3-D Ground water flow equations in Cartesian and polar coordinates, equations for steady radial flow into a well in case of confined and unconfined aquifers, equations for effect of uniform recharge in a fully penetrating unconfined aquifer, well flow near aquifer boundaries.

UNIT - II
Equations for unsteady radial flow into a well in case of confined aquifer, determination of Storage coefficient and Transmissibility (S and T) by Theis's graphical method, Cooper-Jacob's and Chow's method. Image well theory, partial penetration of wells, multiple well systems.

UNIT - III
Artificial recharge of aquifers: Introduction, current trends in artificial recharge, spreading methods, injection wells, technical feasibility and economic viability. -Geophysical methods in groundwater Exploration: surface geophysical methods: electrical resistivity method, seismic method, magnetic method, determination of aquifer thickness.

UNIT - IV
Quality of groundwater and seawater intrusion in coastal aquifers: Dissolved constituents in groundwater and their effects, fluctuations in groundwater, mechanism of salt water intrusion, Ghyben-Herzberg relation, slope and shape of the interface, prevention and control of seawater intrusion, case studies involving sea water intrusion.
Topics to be taught by Industry Subject Expert :

UNIT - V
Models in ground water analysis: Major applications of ground water models, sand models, viscous fluid models, membrane models, thermal models, electric-Analog models, numerical modeling of ground water systems.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Ven-Te-Chow, '*Hand book of Applied Hydrology'*, McGraw-Hill Book Company, New York. 1964
2	Todd, D.K. '*Groundwater Hydrology'*, John Wiley and Sons, New York. 1980
3	Karanth, K. R. '*Groundwater Assessment, development and Management'*, Tata Mc Graw – Hill publishing company New Delhi. 1987
4	Raghunath H.M, '*Ground water'* Wiley Eastern Ltd, New Delhi. 1982
5	Wang Herbert. F. and Anderson Mary. P.(), '*Introduction to groundwater modeling; FDM and FEM'*, Academic Press, New York. 1995
6	Rastogi, A.K. '*Numerical Groundwater Hydrology'*, Penram International publishing (India) Pvt Ltd. 2007.

CE 205	APPLIED STATISTICS IN Water Resources ~~E~~					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to frequency distribution and sampling
2	Concepts of regression and correlation
3	Knowledge about sampling distributions and tests of significance

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to compute central tendencies and sampling applications
CO-2	Fitting of Probability distribution to data, computations of the mathematical expectation and moment generating function.
CO-3	Applications Regression techniques in water resources engineering field.
CO-4	Ability to compute various parameters in multivariate data.
CO-5	Applications of tests of statistical significance especially in Hydrological studies

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	2	1	2	1	1
CO-2	3	3	1	1	1	2
CO-3	2	3	1	1	1	2
CO-4	2	3	1	2	1	1
CO-5	2	3	2	1	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction : Frequency Distribution - Measures of central tendency-measures of dispersion - Standard error - Skewness - kurtosis-moments - definitions and applications, Karl Pearson's, Bowley's , Kelly 's , moment's methods - sampling- simple random sampling - stratified sampling - systematic sampling- sample size determination , and applications in Water Resources Engineering.

UNIT - II
Probability : axioms of probability - addition theorem on probability - conditional probability- independent events and multiplication theorem on probability - Baye's theorem - Random variables- discrete and Continuous random variables - probability distribution and density functions- Mathematical expectation - Moment generating function
Statistical Distribution: Binomial, Poisson, Normal distributions and fitting of these distribution -exponential distribution - gamma distribution - uniform distribution - chi-square distribution ,and applications in Water Resource Engineering

UNIT - III
Regression and Correlation: Simple , multiple, total ,partial linear and non-linear regressions-regression coefficients-regression equations – Stochastic process- classification of Random Processes –Stationary Process- Markov Process- Markov Chain – Examples of Markov Chains- applications in Water Resources Engineering

UNIT - IV
Multivariate Data Distributions: Types of data - Base vectors and matrices - simple estimation of Centroid, standard deviation ,dispersion ,variance and covariance - correlation matrices - Principal component analysis and Time series analysis .
Topics to be taught by Industry Subject Expert : Unit IV practical applications in WRE- Markov Process,

UNIT - V
Exact Sampling Distributions and Tests of Significance : Chi-square distribution - student's t- distribution and F - distribution,-sampling and non-sampling errors - sampling fluctuations .sampling distribution of a statistic- standard error a statistic - Estimation theory - point estimation - interval estimation- confidence limits for population parameter - confidence interval of the mean - Testing hypothesis - Large sample and small sample tests - Tests of significance of single mean - difference between two means , difference between two variances -test of significance for single proportion (small samples and large samples) t-test, chi -square test - F-test , applications in Water Resources Engineering.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Snedecor, G.W., and W.G. Cochran , '*Statistical Methods'*, East West Press, NewDelhi. 1994
2	Alfredo, H.S. and Tang Wah , '*Probability Concepts in Engineering Planning and Design: Vol-I (Basic Principles)*, John Wiley & Sons, New York. 1975
3	V. Sundarpandian *Probability, Statistics, Queuing theory* , PHI Publishers 2011
4	G.Shankar Rao *Probability and Statistics for Science and Engineering*, University Press. 2011
5	SC Gupta and VK Gupta *Fundamentals of Mathematical Statistics* Sultan Chand & Sons Publishers, 2014
6	D.R. Helsel and R.M. Hirsch (2002) Statistical Methods in Water Resources, USGS Science for a changing world. Publication available at: http://water.usgs.gov/pubs/twri/twri4a3/
7	Hwei P. Hsu (1996)Theory and Problems of Probability, Random Variables, and Random Processes, Schaum Series

CE 206	FREE SURFACE FLOWS					
Pre-requisites	Basic knowledge of parameters related to open channel flows, types of flows and channels in UG Programme		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to the basic concepts of free surface flows
2	Description of the equations of varied flows
3	Basic concepts of Fluvial Hydraulics and design of stable channels
4	
5	
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Comprehensive understanding about the basic concepts of open channel flows
CO-2	Acquaintance with the application of varied flow concept
CO-3	Knowledge of unsteady flows principles and its applications to water resources engineering problems
CO-4	Propensity for the selection and design of appropriate stable channel approaches.
CO-5	Knack for the applications of principles and theory of non-prismatic channels

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	2	2	3	1	
CO-2	1	3	2	1	1	
CO-3	1	3	2	3		1
CO-4	1	2	3	2	1	
CO-5	1	2	2	3	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Basic Concepts: Velocity and Pressure distribution, effect of slope on pressure distribution, energy and momentum principles, features of uniform flow, conveyance and section factor of a channel section, hydraulic exponent for uniform flow computation, flow computations in compound sections.

UNIT - II
Varied Flow: Application of specific energy and specific force concepts, Computation of flow profiles by Direct Integration and standard step method, profiles resulting from change in bed slope, jumps in non-rectangular channels, design considerations for supercritical flow

UNIT - III
Unsteady Flow: Continuity equation, momentum equation, uniformly progressive flow, positive and negative surges, SVF with increasing and decreasing discharges

UNIT - IV
Fluvial Hydraulics: Basic Characteristics of River Beds and Sediments, initiation of Motion, Regimes of Flow, Resistance to Flow in Alluvial Streams, Theories of Bed Load, Suspended and Total Load, Design of Stable Channels by different methods – Tractive Force, Simons, Blench, Minimum Energy.
Topics by Industry Subject Expert : Case studies pertaining to issues and solutions in designing the stable channels

UNIT - V
Non-Prismatic channels: Introduction, response to a disturbance, gradual change in boundary, flow at a corner, constrictions, super critical flow through constrictions, obstructions, flow between bridge piers, under flow gates, channel junctions.
Topics by Industry Subject Expert : complete UNIT

Suggested Reading:

1	Ven Te Chow, *'Open Channel Hydraulics'*, McGraw-Hill Book Company, New York, 1959
2	French, R. H., *'Open Channel Hydraulics'*, McGraw-Hill Book Company, New York, 1986
3	Hanif Chaudhry, M., *'Open-Channel Flow'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1993
4	Ranga Raju, K.G., *'Flow Through Open Channels'*, Tata McGraw-Hill Publishing Company, New Delhi, 1983
5	Bakhmeteff, B.A., 'Hydraulics of Open Channels', McGraw-Hill Book Company, New York, 1932
6	Garde and Ranga Raju, K. G. '*Mechanics of Sediment Transportation and Alluvial Stream Problems'*, Wilsey Eastern, New Delhi, 1980
7	Graf, W.H., *'Hydraulics of Sediment Transport'*, McGraw-Hill Book company, New York, 1971

Program Elective IV

CE220	**HYDRAULIC STRUCTURES**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Description of the design aspects of different types spillways
2	Knowledge regarding the design of energy dissipation arrangements
3	Awareness about urban storm drainage and concepts of dam safety
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Skills for the application of principles involved in the design of spillways
CO-2	Aptitude to plan with latest improvements in the design of hydraulic structures
CO-3	Application of principles of design to different types energy dissipation arrangements
CO-4	Propensity to plan and apply the design principles of urban storm-water drainage systems for the sustainable development of the society
CO-5	Knack for the application of principles and concepts of dam safety guidelines

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	3	2	2	1	
CO-2	2	3	2	2	1	
CO-3	2	3	2	2	1	
CO-4	2	3	2	2	1	
CO-5	2	3	2	2	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
I*ntroduction* – Functions of Spillways, Design flood, Hydraulic design steps for Side Channel spillway, Chute Spillway, and Shaft Spillway

UNIT - II
Roller Compacted Concrete (RCC) dams, Hydraulic design steps for Stepped spillway, and air regulated siphon spillway. Hydraulic design steps for Labyrinth weir and Duck bill spillway

UNIT - III
Energy Dissipaters – Factors governing the design, design criteria of energy dissipaters as per U.S.B.R. Cavitation and air entrainment in spillway as per BIS 2804-1989

UNIT - IV
Urban drainage: Quantity of storm water, design of storm water drainage system, SCS curve technique, design of culverts for submerged and partly submerged flow situations, airport drainage.
Topics to be taught by Industry Subject Expert : Unit IV practical applications in WRE

UNIT - V
Dam safety – Principles and concepts for new dams and existing dams, hazard classification of dams, spillway capacity criteria, safety of existing embankment dams and appurtenant structures.
Topics to be taught by Industry Subject Expert : UNIT V

Suggested Reading :

1	Water Resources Technical Publication, *'Design of Small Dams (USBR)'* , Oxford and IBH Publication Company, New Delhi, 1974
2	Vischer D.L. & W.H. Hager , *'Dam Hydraulics'* , Wiely International Edition., New York , 1998
3	Novak P., A.I.B. Moffat, R. Nalluri & R. Narayanan, *'Hydraulic Structures'*, Unwin Publishers, London, 1990
4	Larry-W-Mays, *'Water Resources Engineering'*, John Wiley & Sons, Singapore, 2006
5	John E. Gribbin, *'Hydraulics and Hydrology for Stormwater Management'*, Delmar Publishers, New York, 1997
6	Creager W.P., Joel D. Justin and Julion Hinds, *'Engineering for Dams'* Volume I,II & III, John Wiley and Sons Inc, New York, 1961

CE221	**WATER POWER ENGINEERING**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	An overview of hydro power development
2	Exposure to the principles involved in the design of surge tanks and penstocks
3	Description regarding the concepts of speed and pressure regulation
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Aptitude to plan for hydro power development projects
CO-2	Skills for the application of principles involved in the design of intakes and power house dimensioning
CO-3	Ability to analyse and synthesize the pipe networks
CO-4	Capacity to perform and apply the design principles of water hammer pressures, anchor blocks and surge tanks
CO-5	Propensity for application of subject knowledge towards sustainable and economic development of human welfare

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	3	2	2	1	
CO-2	3	3	2	2	1	
CO-3	3	3	2	2	1	
CO-4	2	3	2	2	1	
CO-5	2	3	2	2	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
General: Comparison with other methods of power generation, Site investigation and location of water power plant, Study of stream flow data for power estimation - Pondage and storage, and load prediction.
Development of power: Different types of layout, component parts of waterpower schemes.

UNIT - II
Water Conductor System: Intake – Various types, Hydraulics of Intakes, gates and their operations.
Powerhouse: General arrangements and criteria for fixing power house dimensions, including mechanical & electrical equipment details.

UNIT - III
Pipe networks : Analysis by Hardy Cross Method, Joining and laying of pipes and pipe specials (Cast Iron, Ductile Iron, Pre stressed Concrete, and HDPE).
Penstocks and Pressure Shafts: Classification, Hydraulic design, Economical diameter of Steel Penstocks

UNIT - IV
Hydraulic transients and Surge Tanks: Introduction, effect of rapid valve closure, unsteady compressible flow, surge protection, and method of characteristics to water hammer. Water Hammer theory – Joukowsky's method, and Allieve's method
Topics to be taught by Industry Subject Expert : Unit IV practical applications in WRE

UNIT - V
Anchor Blocks: Various types and design of simple anchor blocks, Design of simple surge tanks, and method of characteristics to the design of surge tanks.
Pressure Regulation: General features, auxiliary devices, automatic and remote control devices, governor improvement methods, performance characteristics and speed regulation of different turbines.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Creager W. P., and Justin J..D. , *'Hydroelectric Hand Book'*, John Wiley and Sons Inc New York,1959
2	Barrows, H.K., *'Water Power Engineering'*, Tata McGraw-Hill Publishing Company, New Delhi, 1980
3	EI-Wakil, M.M., *'Power Plant Technology'*, McGraw-Hill Book Company, New York, 1984
4	Bhave, P.R., Gupta, R., *'Analysis of flow in water distribution networks'*, Narosa Publishing House, New Delhi, 2006
5	Modi, P.N., *'Irrigation, Water Resources and Water Power Engineering'*, Standard Book House, New Delhi, 1988

CE222	FLOOD CONTROL AND MANAGEMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Awareness about flood characteristics and flood forecasting systems
2	Description of Flood mitigation, adjustment, and regulation
3	Knowledge of Hydrological time series analysis
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Application of mathematics of flood forecasting and flood routing as well as adaptation of policy criteria for flood control
CO-2	Aptitude to apply flood routing techniques in a regime
CO-3	Capacity to adopt various flood mitigation measures
CO-4	Propensity to employ flood plain adjustments and other techniques for flood management.
CO-5	Skill to analyze hydrologic time series for water resources applications.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	1	1	2	1	
CO-2	2	3	1	2	1	
CO-3	2	2	2	2	2	
CO-4	1	2	2	2	1	
CO-5	1	2	1	1	1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Flood characteristics and forecasting : Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.
Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

UNIT - II
Flood routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.

UNIT - III
Flood mitigation : Flood mitigation reservoirs(purpose, location, size and operation) levees and flood walls (location, maintenance and flood fighting), flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.

UNIT - IV
Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards, classification of flood plain land, and regulation of flood plain use, river training works (guide banks, approach and afflux embankments, spurs / groynes, artificial cut-offs, bank protection, pitched banks, and miscellaneous methods).
Topics to be taught by Industry Subject Expert :

UNIT - V
Hydrologic Time Series Analysis: Independent and Auto-correlated data, structure of hydrologic time series, trend, jump, seasonality, stationarity, Auto-covariance and Auto-correlation Function, Correlogaram Analysis, spectral Analysis, Analysis of Multi-Variant Hydrologic series.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Ven Te Chow (1964), 'Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York.
2	Linsley, R. K. and Franzini A. W. (1992), 'Water Resource Engineering', McGraw-Hill Publishers, New York.
3	Varshney, R. S. (1979), 'Engineering Hydrology', Nem Chand Publishers, Roorkee.
4	Jaya Rami Reddy, P. (1987), 'A. Text Book of Hydrology', Lakshmi Publishers, New Delhi.
5	Daniel H. Hoggan (1989), 'Computer Assisted Flood Plain Hydrology and Hydraulics', McGraw-Hill Publishers, New York.

Program Elective V

CE223	**GEOSPATIAL APPLICATIONS TO WATER RESOURCES ENGINEERING**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Discuss the various spatial and non-spatial data types, and data base management techniques
2	Develop the concepts and professional skills in utility of geospatial techniques
3	Improve the working knowledge of geospatial techniques in field problems
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the geospatial technology relating to the data acquiring and processing that is associated with geographic locations
CO-2	Apply Geospatial techniques in the decision support systems useful for decision makers and community services.
CO-3	Ability to solve the problems related to the natural resource management, environment, Urban planning and Infrastructure development, etc.
CO-4	Able to generate the thematic maps using Geospatial techniques
CO-5	Apply the concept of Geospatial Techniques to the Civil Engineering problems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	2	2	2	1	1
CO-2	2	2	2	1	1	1
CO-3	2	1	1	2	2	1
CO-4	1	2	2	2	1	1
CO-5	1	1	1	1	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction - Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems
Projections and Coordinate Systems - Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT - II
Data Acquisition and Data Management - data types, spatial, non-spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty

UNIT - III
Data Modeling - Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.
GIS Analysis and Functions - Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non- spatial data.

UNIT - IV
Applications of GIS - Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.
Topics to be taught by Industry Subject Expert :

UNIT - V
Introduction to Remote Sensing - General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Burrough, P. A., and McDonnell R. A. *Principles of Geographical Information Systems.* Oxford University Press, New York, Pp.333. 1998
2	Choudhury S., Chakrabarti, D., and Choudhury S. *An Introduction to Geographic Information Technology*. I.K. International Publishing House (P) Ltd, New Delhi, Pp.276. 2009
3	Kang-tsung Chang. *Introduction to Geographical information Systems.* Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi, Pp.432. 2006
4	Lilysand T.M., and Kiefer R.W. *Remote Sensing and Image Interpretation*. John Wiley and Sons, Fourth Edition, New York, Pp.724. 2002
5	Sabins F.F. Jr. (1978). *Remote Sensing Principles and Interpretations.* W.H. Freeman and Company, San Francisco, Pp. 426. 1978
6	Tor Bernhardsen. *Geographical Information System.* Wiley India (P) Ltd., Third Edition, New Delhi, Pp. 428. 2002
7	Hoffman-Wellenhof, B, et al. *GPS Theory and Practice.* Fourth Edition, Springer Wein, New York. 1997.

CE224	GROUNDWATER CONTAMINATION: TRANSPORT AND REMEDIATION					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to the concepts of contaminant transport.
2	Description of the NAPL impacts in source areas and plumes by modeling approaches.
3	Illustration of the various evaluation schemes and emerging remediation techniques.
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Comprehend the fundamentals of groundwater contamination and transport.
CO-2	Knowledge of various sources and contaminants pertaining to groundwater contamination.
CO-3	Ability to critically review and interpret transport processes and mechanisms to solve problems of groundwater flow and solute transport
CO-4	Understand the contaminant transport in unsaturated zones and decide the appropriate remediation methods and treat them effectively.
CO-5	Application of knowledge to solve problems of contaminant transport by modeling techniques

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	3	2	1	-	-
CO-2	-	2	2	1	1	-
CO-3	-	2	2	-	1	1
CO-4	-	-	1	3	1	1
CO-5	-	3	1	2	1	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction to groundwater contamination: Hydrologic cycle, groundwater hydrology, groundwater contamination and transport, evolution of groundwater information, groundwater remediation, and groundwater movement, general flow equations and well mechanisms.

UNIT - II
Sources and types of groundwater contamination: Introduction, under ground storage tanks, landfills, surface impoundments, waste disposal of injection wells, radioactive contaminants, classification of organic compounds, inorganic compounds in ground water. Non aqueous phase liquids (NAPL'S): types, general processes, transport, fate of NAPL'S in subsurface.

UNIT - III
Contaminant transport mechanisms: Introduction, advection process, diffusion and dispersion process, mass transport equation, governing flow and transport equations, analytical methods, tests for dispersivity.

UNIT - IV
Flow and transport in the unsaturated zone: Capillary action, governing equations for unsaturated flow, transport process in unsaturated zone and its governing equations- Remediation alternatives: introduction to remediation method and alternatives, containment methods for source control, hydraulic controls and pump and treat systems, bio-remediation, soil vapor extraction systems, emerging remediation technologies.
Topics to be taught by Industry Subject Expert :

UNIT - V
Numerical modeling of contaminant transport: Introduction, numerical methods, finite difference methods(FDM), finite element methods (FEM), methods of characteristics, numerical flow models, contaminant transport models, applying numerical model to field sites.
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Philip. B. Bedient, Hanadis. Rifai ,and Charles. J. Newell '*Groundwater Contamination: Transport and Remediation*', Prentice-Hall, New Jersey. (1999)
2	Lakshmi.N.Reddi, Hilary, I.Inyang '*Geo-Environmental Engineering: Principles and Applications',* CRC Press, Florida. 2000
3	Zheng Zheng Chunmiao and Gordon. D. Bennett '*Applied Contaminant Transport Modeling (Theory and Practice)'*, John Wiley and Sons, New York. 1995
4	Wang Herbert. F., and Anderson Mary.P. *'Introduction to Groundwater Modelling Finite Difference and Finite Element Methods'*, Academic Press, San Diego, 1995.

CE225	MODELS OF AIR AND WATER QUALITY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Description of the concepts of water and air pollution
2	Exposure to the principles of modeling and their application to water bodies
3	An overview regarding reservoir sedimentation
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Capable of analyzing stream water and air quality issues.
CO-2	Introduction of modeling techniques and standards
CO-3	Capable to estimate the reservoir and lake sedimentation problems and understand various methods to control them.
CO-4	Understanding of Air pollution effects and measures to controlling them.
CO-5	Ability to model and propagation of pollution plume models.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	1	1	1	1	1
CO-2	1	2	1	1	1	1
CO-3	1	2	2	-	1	1
CO-4	1	2	1	-	1	1
CO-5	1	3	1	-	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Introduction: Water pollutants and their sources Stream sampling – hydrological factors affecting the stream self – purification. Steady state conservative system, steady state with non-conservative pollutants.

UNIT - II
Stream pollution modeling concepts: Measurement of BOD – Streeter Phelp's equation – Effect of temperature on BOD, Kinetic reaction rate – Stream re-aeration. Analysis of DO Sag curve by Streeter – Phelps equation method, statistical method.

UNIT - III
Water Quality of Lakes and Reservoirs: Mass balance model, Phosphorus model, Thermal stratification, Eutrophication of lakes-Reservoir sedimentation: Determination of sediment yield, measurement of suspended load, Bed load estimation by empirical methods, control of sedimentation

UNIT - IV
Air Pollution: Sources and effects, scales of concentration, classification and properties of air pollutants effects of air pollution and air pollution standards, dispersion of air pollutants. Meteorological aspects of air pollution and atmospheric stability
Topics to be taught by Industry Subject Expert :

UNIT - V
Plume behavior, modeling of air pollution: Gaussian plume model – determination of maximum ground level concentration due to elevated source pollutants. Limitations of Gaussian model, effective stack height concept and estimation of plume rise**.**
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Keily Gerard, '*Environmental Engineering'* McGraw-Hill International Publishers, London. 1998.
2	Fischer, H.B., E. John List, Robert C.Y. Koh, Jorg Imberger, and Norman H. Brooks , '*Mixing in Inland and Coastal Waters'* Academic Press Inc., New York. 1979.
3	Nelson Leonard Nemerow , '*Scientific Stream Pollution Analysis'* McGraw-Hill Publishers. 1974
4	Wurbs, R. A. and James, W.P, '*Water Resources Engineering'*, Prentice-Hall of India, New Delhi. 2002
5	Graf, W.H. , '*Hydraulics of Sediment Transport'*, McGraw-Hill Book company, New York, 1971
6	Yalin, M.S. , '*Mechanics of Sediment Transport*', Pergaman Press, Oxford. 1999

Open Elective

OE 941 BM	MEDICAL ASSISTIVE DEVICES					
(OPEN ELECTIVE)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
2	To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
3	To develop improved lower-extremity devices

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Apply fundamental knowledge of engineering in rehabilitation
CO-2	Apply analytical skills to assess and evaluate the need of the end-user
CO-3	Develop self-learning initiatives and integrate learned knowledge for problem solving
CO-4	Understand the basics of robotics and apply their principles in developing prosthetics
CO-5	Apply the knowledge of computers in solving rehabilitation problems

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	1	1		
CO-2	1	1	1	1		
CO-3		1	1	1		
CO-4	1	1	1			
CO-5	1	1	1			

Unit – I
Introduction to Rehabilitation Engineering, Measurement and analysis of human movement, Disability associated with aging in the workplace and their solutions, clinical practice of rehabilitation engineering.

Unit – II
Assistive Technology, Seating Biomechanics and systems. Wheeled Mobility: Categories of

Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair propulsion. Power Wheelchair Electrical Systems. Control. Personal Transportation. Auxiliary devices and systems.

Unit – III
Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Measurement tools and processes: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

Unit – IV
Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

Unit – V
Augmentative and Alternative communication technology, Computer applications in Rehabilitation Engineering, telecommunications, and Web Accessibility.

Suggested Reading:

1	Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2	Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3	Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4	Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

OE 942 BM	MEDICAL IMAGING TECHNIQUES					
(OPEN ELECTIVE)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To familiarize the students with various medical imaging modalities.
2	To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
3	To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Interpret the working principle and operating procedure and applications of X-ray equipment.
CO-2	Understand the image reconstruction techniques and applications of CT.
CO-3	Summarize the image acquisition and reconstruction techniques in MRI.
CO-4	Comprehend the working principle, modes and medical applications of ultrasound imaging.
CO-5	Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1		1	1	1		
CO-2	1	1	1	1		
CO-3	1	1	1			
CO-4	1		1			
CO-5			1	1		

Unit – I
X ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers. Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment, Digital Radiography and flat panel detectors. Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and

detectors.

Unit – II
Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

Unit – III
Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging. Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI.

Unit – IV
Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion. Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

Unit – V
Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera. Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET). Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:

1	Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2	S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3	A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4	Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2ndEd. 1992.
5	Stewart C. Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

OE 941 CE	GREEN BUILDING TECHNOLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of energy use and energy processes in building.
CO-2	Identify the energy requirement and its management.
CO-3	Know the Sun-earth relationship vis-a-vis its effect on climate.
CO-4	Be acquainted with the end-use energy requirements.
CO-5	Be familiar with the audit procedures of energy

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	1	1		
CO-2		1	1	1		
CO-3	2	1	1	1		
CO-4	1	1	1			
CO-5		1				

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

Chapter – II
Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

Chapter – III
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

Chapter – IV
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

Chapter – V
Energy management options - Energy audit and energy targeting - Technological options for energy management.

Suggested Reading:

1	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2	Carter, W. Nick, (1991): Disaster Management, Asian Development Bank, Manila.
3	Sahni, Pardeep et.al. (eds.) (2002), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

OE 942 CE	COST MANAGEMENT OF ENGINEERING PROJECTS					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concepts of cost management
2	Fundamentals of cost overruns
3	Introduce the concepts of Quantitative techniques for cost management Linear Programming, PERT/CPM.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
CO-2	Ability to appreciative detailed engineering activities of the project and execution of projects
CO-3	Preparation of project report and network diagram
CO-4	Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
CO-5	Applications of various quantitative techniques for cost management

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-		1		
CO-2	1	1	1	1	-	
CO-3	-	-	1	1	3	1
CO-4	1	1	1	1	-	
CO-5	1	1	1			

Chapter – I
Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

Chapter – II
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

Chapter – III
Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Chapter – IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector- Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Chapter – V
Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading:

1	Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2	Charles T. Horngren and George Foster, Advanced Management Accounting
3	Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4	Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5	N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE 941 CS	BUSINESS ANALYTICS					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding the basic concepts of business analytics and applications
2	Study various business analytics methods including predictive, prescriptive and prescriptive analytics
3	Prepare the students to model business data using various data mining, decision making methods

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand the basic concepts of business analytics
CO-2	Identify the application of business analytics and use tools to analyze business data
CO-3	Become familiar with various metrics, measures used in business analytics
CO-4	Illustrate various descriptive, predictive and prescriptive methods and techniques
CO-5	Model the business data using various business analytical methods and techniques

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	1	1		
CO-2	-	1	1	1		
CO-3	1	1	1	1		
CO-4	1	1	1			
CO-5		1	1			

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

Chapter – II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization.

Chapter – III
Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

Chapter – IV
Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building.

Chapter – V
Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

Suggested Reading:

1	U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3	S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2	https://nptel.ac.in/courses/110105089/

OE 941 EC	ELEMENTS OF EMBEDDED SYSTEMS					
(OPEN ELECTIVE)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding various Embedded Design strategies
2	Designing Micro controller based Embedded Systems
3	Designing FPGA Based Embedded Systems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand Embedded Design Strategies and architecture of Arduino Board
CO-2	Program using various onboard components of Arduino
CO-3	Design real time interfacing with Arduino
CO-4	Understand Design Flow of FPGA, programming FPGA using Verilog HDL
CO-5	Implement combinational and sequential circuits using verilog HDL

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	1	1		
CO-2	1	1	1	1		
CO-3		1	1			
CO-4						
CO-5		1	1	1		

Unit – I
Embedded Systems Design Strategies: Micro Controller, DSP, FPGA, Introduction to Arduino (Micro controller Board), Components of Arduino, Architecture and Pin Configuration of ATMega328, Ports of ATMega328.

Unit – II
Interfacing: Interfacing Switches, LEDs, Analog to Digital Converter, Digital to Analog Converter, Interfacing and Programming I2C, SPI

Unit – III
Real Time Programming: Interfacing Key Pad, 7-segment display, LCD, Interfacing Sensors, Interfacing Stepper Motor**,** USB programming

Unit – IV
FPGA Based Embedded Design: FPGA Design flow, Introduction to Verilog HDL**,** Basic building blocks, Data types of Verolog HDL, Behavioral Modelling, Data Flow Modelling, Structural Modelling, Hierarchal Structural Modelling, Case Studies on Verilog HDL descriptions of Basic Circuits

Unit – V
Modelling of Circuits: Verilog HDL Implementation of Combinational MSI Circuits, Verilog HDL Implementation of Sequential MSI Circuits, Finite Sate Machine Design, Tasks and Functions, Introduction to Test Benches

Suggested Reading:

1	Ming-Bo Lin, Digital System Designs and Practices Using Verilog HDL and FPGAs, Wiley India, 2008
2	Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, 2005
3	Simon Monk, Programming Arduino: Getting Started with sketches, Mc.Hill, 2016

Web Resources:

1	www.arduino.cc
2	www.learn.sparkfun.com/tutorials/arduino

OE 941 EE	WASTE TO ENERGY					
	(OPEN ELECTIVE)					
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To know the various forms of waste
2	To understand the processes of Biomass Pyrolysis.
3	To learn the technique of Biomass Combustion.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of conservation of waste
CO-2	Identify the different forms of wastage.
CO-3	Chose the best way for conservation to produce energy from waste.
CO-4	Explore the ways and means of combustion of biomass.
CO-5	Develop a healthy environment for the mankind.

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	1		1	-	
CO-2	-	-			-	
CO-3	-			2		
CO-4	-	-				
CO-5	-	2	-	-		

Chapter – I
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Chapter – II
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Chapter – III
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Chapter – IV
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Chapter – V
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1	Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE 942 EE	POWER PLANT CONTROL AND INSTRUMENTATION					
(OPEN ELECTIVE)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	The operation of different types of power plants.
2	The basic working principle of instruments for measurement of electrical and non-electrical quantities like Temperature Pressure flow level measurements.
3	The instrumentation and protection systems applied in thermal power plant.
4	The control techniques employed for the operation of modern power generation plant

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Explain the different methods of power generation. Along with Piping and Instrumentation diagram of boiler.
CO-2	Select various measurements involved in power generation for measuring electrical and non-electrical parameters.
CO-3	Identify the different types of analyzers used for scrutinizing boiler steam and water.
CO-4	Model different types of controls and control loops in boilers.
CO-5	Illustrate the methods of monitoring and control of different parameters like speed, vibration of turbines

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1				1		
CO-2		1	1	1		
CO-3		1	1			
CO-4	1					
CO-5	1	1	1	1		

Unit – I
Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plants, block diagram, details of boiler processes, Piping and Instrumentation diagram of boiler, cogeneration.

Unit – II
Electrical measurements, current, voltage, power, frequency, power factor etc, non-electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector, smoke density measurement, dust monitor.

Unit – III
Flue gas oxygen analyzer: Analysis of impurities in feed water and steam, dissolved oxygen analyzer. Chromatography, pH meter, fuel analyzer, pollution monitoring instruments.

Unit – IV
Combustion control, air / fuel ratio control, furnace draft control, drum level control, main steam and reheat steam temperature control, super heater control, air temperature, distributed control system in power plants, interlocks in boiler operation.

Unit – V
Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.

Suggested Reading:

1	Sam G. Dukelow, The Control of Boilers, Instrument Society of America, 2nd Edition, 2010.
2	P.K. Nag, „Power Plant Engineering", Tata McGraw-Hill, 1st Edition, 2001.
3	S.M. Elonka and A.L. Kohal, "Standard Boiler Operations", Tata McGraw-Hill, 1st Edition, 1994.
4	R K Jain, "Mechanical and Industrial Measurements", Khanna Publishers, 1st Edition, 1995.
5	E Al Wakil, "Power Plant Engineering", Tata McGraw-Hill, 1st Edition, 1984.

OE 941 ME	OPERATION RESEARCH					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To understand the dynamic programming to solve problems of discrete and continuous variables
2	To apply the concept of non-linear programming and carry out sensitivity analysis
3	To understand deterministic and probabilistic inventory control models.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand the basics of OR, including mathematical modeling, feasible solutions and optimization.
CO-2	Able to carry out sensitivity analysis.
CO-3	Apply PERT/CPM in project management.
CO-4	Select appropriate inventory control model.
CO-5	Able to apply dynamic programming and understand the concept of non-linear programming.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	3	2	1	2
CO-2	3	1	2	3	2	-
CO-3	1	3	3	1	2	2
CO-4	3	2	1	3	1	1
CO-5	2	1	3	2	2	2

Unit – I
Development, Different Phases, Characteristics, Operations Research models and applications. Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method: Big M and Two Phase method.

Unit – II
DUALITY: Duality theory, primal-dual relationships, Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis.

Unit – III

Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity. **Inventory models** – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

Unit – IV
Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines. **Game Theory**: Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2 x 2, m x 2), Algebraic and graphical methods. **Nonlinear programming problem:** - Kuhn-Tucker conditions.

Unit – V
Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population. Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1	H.A. Taha, Operations Research, An Introduction, PHI,2008
2	H.M. Wagner, Principles of Operations Research, PHI, Delhi,2010
3	J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008.
4	Frederick S. Hillier, Gerald J. Lieberman, Operations Research, 10thEdition, McGraw Hill Pub. 2017.
5	Panner selvam, Operations Research: Prentice Hall of India, 2010.
6	Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint, Pearson Education Asia. 2002,

OE 942ME	COMPOSITE MATERIALS					
	(OPEN ELECTIVE)					
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Study the concepts of composite construction.
2	Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
3	Apply the concepts for design of multi-storey composite buildings.
4	Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of composite construction, and analysis and designs of composite beams.
CO-2	Analyse and design the composite floors
CO-3	Select suitable materials for composite columns,
CO-4	Analyse composite trusses and understand connection details.
CO-5	Analyse and design the multi-storey composite buildings

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	-	
CO-2	-	-	-	-	-	1
CO-3	-	1	-	-	-	
CO-4	-	-	-	-	-	
CO-5	-		-	-	-	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions. Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

Chapter – II
Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

Chapter – III
Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

Chapter – IV
Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

Chapter – V
Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1	R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2	"INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3	"INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4	"INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5	"INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6	IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

OE 943 ME	INDUSTRIAL SAFETY					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Causes for industrial accidents and preventive steps to be taken.
2	Fundamental concepts of Maintenance Engineering.
3	About wear and corrosion along with preventive steps to be taken
4	The basic concepts and importance of fault tracing.
5	The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify the causes for industrial accidents and suggest preventive measures.
CO-2	Identify the basic tools and requirements of different maintenance procedures.
CO-3	Apply different techniques to reduce and prevent Wear and corrosion in Industry.
CO-4	Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
CO-5	Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	-	1			
CO-2	-	1	1	1		
CO-3	1	1	-	1		
CO-4		1	1	1		
CO-5	1	1	1	1		

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

Chapter – II
Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Chapter – III
Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

Chapter – IV
Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

Chapter – V
Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Reading:

1	H. P. Garg, "Maintenance Engineering", S. Chand and Company
2	Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3	Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4	Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

OE 941 LA	INTELLECTUAL PROPERTY RIGHTS					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	-
CO-2		1		1	1	
CO-3		1		1	1	
CO-4					1	2
CO-5					1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Chapter – II
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Chapter – III
Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer**.**

Chapter – IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Chapter – V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
2	“Mayall, “Industrial Design”, McGraw Hill,1992
3	“Niebel, “Product Design”, McGraw Hill,1974.
4	“Asimov, “Introduction to Design”, Prentice Hall,1962.
5	“Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”,2016.
6	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand,2008

CE252	GEOGRAPHICAL INFORMATION SYSTEM LABORATORY					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understands the concept of Geographical Information System
2	Application of ArcGIS Software tools to Civil Engineering problems
3	Preparation of Thematic maps using software tools

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Students are expected to have gained knowledge on ArcGIS software and its applications to Civil Engineering
CO-2	Ability to develop the thematic maps using various tools of ArcGIS Software
CO-3	Able to extract the geospatial data from the remotely sensed data

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	--	2	--	--	1
CO-2	2	-	1	--	1	1
CO-3	2	--	2	3	2	--

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

1	Georeferencing of toposheets
2	Digitization of Map/Toposheet
3	Delineation of Watershed Boundary map
4	Extraction road network map
5	Creation drainage pattern Map

6	Generation Land use/Land cover map
7	Generation of Soil classification map
8	Developing Digital Elevation model
9	Preparation of slope map
10	Estimation of features and interpretation

CE253	COMPUTATIONAL FLUID DYNAMICS LABORATORY					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to the basic concepts of CFD
2	Explanation to importance of various turbulence models
3	Evaluation of flow properties from simulation analysis

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge on the basic concepts of simulation analysis and geometry creation
CO-2	Ability to spawn appropriate mesh and boundary conditions to WRE case studies
CO-3	Acquaintance with various turbulence models and their evaluation

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	2	1	-	-	-
CO-2	1	2	-	1	-	-
CO-3	-	-	-	-	3	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

LIST OF EXPERIMENTS

1	Creation of geometry for various cases
2	Mesh generation and assigning of boundary conditions for uncomplicated cases
3	Verification of application of different turbulence models for simple cases
4	Evaluation of flow characteristics from simulation analysis
5	Simulation of head over the crest in a rectangular notch
6	Flow simulation in a pipe bend for varying angles and diameters
7	Appraisal of flow behavior around an aerofoil
8	Plotting of various contours and vectors for flow over an Ogee weir
9	Analysis of flow for sudden change in the pipe diameters
10	Comparison of simulation results with available physical modeling analysis.

Suggested Reading :

1	Anderson John D. Jr. *Computational Fluid Dynamics – The basics with applications'*, Mc-Graw Hill Education (India) Pvt. Ltd., New Delhi, 2012
2	Versteeg H. K., and Malalsekera W, '*An Introduction to Computational Fluid Dynamics – Finite Volume Method',* Preason Education Ltd., 2007.
3	Chung T. J., '*Computational Fluid Dynamics'*, Cambridge University Press, Cambridge, U.K, 2002.

CE271	MINI PROJECT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	2
Evaluation	**SEE**	-	**CIE**		50 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion and critical appraisal of literature review.
3	Discussion of Methodology for the research problem

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify WR engineering problems by reviewing available latest literature.
CO-2	Study different techniques and analyze complex WR systems.
CO-3	Provide appropriate solutions for the identified problem.
CO-4	

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	1		2	3	
CO-2	2	2		2	3	
CO-3	2	2		2	2	
CO-4						
CO-5	2	1		2	3	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Mini Project will have mid semester presentation and end semester presentation. Mid semester Presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project will be monitored by the departmental committee.

SEMESTER-III

AUDIT I

AC030	**ENGINEERING RESEARCH METHODOLOGY**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the conceptual and philosophical foundation of research methodology for Scientific and Engineering Research
2	Provide an understanding of the importance of literature review and formulating of a good research problem.
3	Offer procedural instruction on how to plan, design & conduct research projects and interpret the data
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the knowledge of research processes (reading, evaluating, and developing) and formulate a research problem
CO-2	Perform literature reviews, present research ideas, plan research projects, and to explain the rationale for research ethics
CO-3	Understand the importance of innovation & patenting and will be aware of rules and regulations about Intellectual Property Rights
CO-4	Select appropriate sampling methods for qualitative and quantitative data collection and processing
CO-5	Applications of various statistical methods for proper characterization, stigmatization, presentation and interpretation of the result of research, to test the Hypothesis by using SPSS software and other similar softwares

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-		-	1	1
CO-2	-	-	1	-	1	
CO-3	-	-	1	-	1	1
CO-4	-	-	2	-	2	2
CO-5	-	-	1	-	2	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

UNIT - I
Disaster: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT - II
Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. Preparation of thesis

UNIT - III
Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT Patent Rights.

UNIT - IV
Data collection and measurement Methods in Civil Engineering: Primary data through:- communication, Designing Questionnaire, Qualitative Research sampling and sampling designs Attitude measurement and scales Data presentation and analysis: Data processing, Univariate and Bivariate analysis, Correlational analysis
Topics to be taught by Industry Subject Expert :

UNIT - V
Measure of central tendency, Measure of central dispersion, Measure of skewness, Measure of kurtosis, parametric and statistic sampling and non-sampling errors, standard error and central limit theorem, sampling distribution, degree of freedom, hypothesis of testing, test statistics and critical region, procedure for hypothesis testing for mean and variance. Introduction to linear regression model and multi-linear regression models, mathematical basis and introduction to SPSS.
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	Stuart Melville and Wayne Goddard, "*Research methodology: an introduction for science & Engineering students*", 2008
2	Ranjit Kumar, 2nd Edition, "*Research Methodology: A Step by Step Guide for beginners" 2009.*
3	Halbert, "*Resisting Intellectual Property*", Taylor & Francis Ltd , 2007.
4	Mayall, "*Industrial Design",* McGraw Hill, 1992.
5	T. Ramappa, "*Intellectual Property Rights Under WTO*", S. Chand, 2008
6	R. Kothari. *"Research Methodology - Methods and Techniques",* 2nd Edition, New

AUDIT-II

AC032CE	**DISASTER MITIGATION & MANAGEMENT**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives : (3 to 5)	
The course is taught with the objectives of enabling the student to:	
1	Introduction of various types of disasters and its effect on structures.
2	Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.
3	Awareness about flood characteristics and flood forecasting systems
4	
Course Outcomes : (5)	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of disaster and different types of disasters
CO-2	Assessment of flood characteristics and methods of forecasting
CO-3	Appropriate mitigation and rehabilitation of structures due to disasters.
CO-4	Adaptation of Regulations to control disasters for vulnerable structures
CO-5	Ability to understand to disaster preparedness and rehabilitation of Civil Engineering structures

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	2	1	1	1	1	1
CO-2	2	2	2	2	1	1
CO-3	2	2	1	1	1	1
CO-4	2	2	1	1	1	0
CO-5	2	2	1	1	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter - I
Disaster: Classifications - Causes - Impacts including social, economic, political, environmental, health, psychosocial, etc. Hazard, Vulnerability, Resilience, Risks.-Disaster-Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.
Natural and Manmade disasters- *Impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes*

Chapter - II
Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems- CWC Recommendations on Floods on reservoir.

Chapter - III
Flood Mitigation and Rehabilitation: Flood mitigation reservoirs (purpose, location, size and operation) levees and flood walls (location, maintenance and flood fighting), flood ways, channel improvements, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation- National Disaster Management Authority- objectives and Provisions of NDMA –Disaster Management Act- 2005

Chapter - IV
Disaster Risk and Mitigation Strategies: - Introduction of Risk, Problems on computation of risk, significance of and objectives of mitigation, types and strategies guidelines for mitigation of natural disasters like floods, earthquake, fire hazards, mitigation plans based on causes and effects.
Topics to be taught by Industry Subject Expert :

Chapter - V
Disaster preparedness and Management: Steps in disaster preparedness- strengthening of community based disaster preparedness- Developing Action plan- Repair of materials, Common types of repairs – Repairs of underwater structures- Gunting- shortcrete-techniques in Civil Engineering- Repair in concrete structures – Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques.
Topics to be taught by Industry Subject Expert :

Suggested Reading : (five for BE and up to seven for ME)

1	Ven Te Chow (1964), 'Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York.
2	Barry A. Richardson (1991) "*Defects and Deterioration in Buildings*", E &FN Spon Press, London, 1991
3	Varshney, R. S. (1979), 'Engineering Hydrology', Nem Chand Publishers, Roorkee.
4	Bungey, J.H (1989) "*Testing of Concrete in Structures*", Chapman and Hall, New Delhi
5	A.R. Santakumar (2006) "*Concrete Technology*", Oxford University Press,New Delhi.6.
6	Gupta Anil K, and Sreeja S. Nair. (2011). *Environmental Knowledge for Disaster Risk Management*, NIDM, New Delhi.

AC031	ENGLISH FOR RESEARCH PAPER WRITING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand that how to improve your writing skills and level of readability
2	Learn about what to write in each section
3	Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission
4	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to plan and prepare paragraphs
CO-2	Writing of abstracts
CO-3	Providing of critical and thorough review of literature
CO-4	Able to exhibit key skills for writing titles
CO-5	Able to show key and necessary skills for paper writing

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-	-	-		1
CO-2	-	-	1	-		
CO-3	-	-	1	-	1	1
CO-4	-	-	2	-	3	2
CO-5	-	-	2	-	2	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter - I
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Chapter - II
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Chapter - III
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Chapter - IV
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature
Topics to be taught by Industry Subject Expert :

Chapter - V
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions - Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission
Topics to be taught by Industry Subject Expert :

Suggested Reading :

1	Goldbort R , *Writing for Science*, Yale University Press (available on Google Books), 2006.
2	Day R , *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
3	Highman N *Handbook of Writing for the Mathematical Sciences*, SIAM. Highman'sbook. 1998
4	Adrian Wallwork *English for Writing Research Papers*, Springer New York Dordrecht Heidelberg London. 2011.

AC033	SANSKRIT FOR TECHNICAL KNOWLEDGE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2	Learning of Sanskrit to improve brain functioning
3	Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4	The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding basic Sanskrit language
CO-2	Ancient Sanskrit literature about science & technology can be understood
CO-3	Being a logical language will help to develop logic in students
CO-4	
CO-5	

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	-	-	1	-	-	-
CO-2	-	1	-	-	-	2
CO-3	-	1	1	-	-	1
CO-4	-	-	-	-	-	-
CO-5	-	-	-	-	-	-

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter - I
Alphabets in Sanskrit,Past/Present/Future Tense, Simple Sentences

Chapter - II
Order Introduction of roots Technical information about Sanskrit Literature

Chapter - III
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Chapter - IV
Topics to be taught by Industry Subject Expert :

Chapter - V
Topics to be taught by Industry Subject Expert :

Suggested Reading:

1	"Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2	Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3	"India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AC034	VALUE EDUCATION					
Pre-requisites			L	T	P	C
			3	-	-	0
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand value of education and self- development
2	Imbibe good values in students
3	Let the should know about the importance of character
4	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Knowledge of self-development
CO-2	Learn the importance of Human values
CO-3	Developing the overall personality

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO6
CO-1	1	1	-	-	1	1
CO-2	1		-	-	-	1
CO-3	-	-	-	-	-	-
CO-4	1	-	-	-	-	-
CO-5	1	-	-	-	-	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter - I
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism-Moral and non- moral valuation. Standards and principles-Value judgements

Chapter - II
Importance of cultivation of values-Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness-Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature ,Discipline.

Chapter - III
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking-Free from anger, Dignity of labour-Universal brotherhood and religious tolerance-True friendship. • Happiness Vs suffering, love for truth-Aware of self-destructive habits-Association and Cooperation-• Doing best for saving nature

Chapter - IV
Character and Competence –Holy books vs Blind faith.-Self-management and Good health-Science of reincarnation-Equality, Non-violence, Humility, Role of Women-All religions and same message-Mind your Mind, Self-control-• Honesty, Studying effectively

Chapter - V

Suggested Reading :

1	Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2	

AC 035	STRESS MANAGEMENT BY YOGA					
(AUDIT COURSE - II)						
Pre-requisites			L	T	P	C
			2	-		0
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Creating awareness about different types of stress and the role of yoga in the management of stress.
2	Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3	Prevention of stress related health problems by yoga practice.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand yoga and its benefits.
CO-2	Enhance Physical strength and flexibility.
CO-3	Learn to relax and focus.
CO-4	Relieve physical and mental tension through Asanas
CO-5	Improve work performance and efficiency.

Course outcome	Program Outcome					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	-	
CO-2	-	-	-	-	-	1
CO-3	-	-	-	1	-	1
CO-4	-	-	-	-	1	1
CO-5	-	-	-	-	1	1

Chapter – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

Chapter – II
Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

Chapter – III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana,

Pranayama and Meditation in the management of stress.

Chapter – IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

Chapter – V
Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1	"Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3	Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1	https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2	https://freevideolectures.com/course/3539/indian-philosophy/11

AC 036	PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS					
(AUDIT COURSE - II)						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn to achieve the highest goal happily
2	Become a person with stable mind, pleasing personality and determination
3	Awaken wisdom in students

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Develop their personality and achieve their highest goal of life.
CO-2	Lead the nation and mankind to peace and prosperity.
CO-3	To practice emotional self regulation.
CO-4	Develop a positive approach to work and duties.
CO-5	Develop a versatile personality.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	1
CO-2	-	-	-	-	-	1
CO-3	-	-	-	-	-	1
CO-4	-	-	-	-	1	1
CO-5	-	-	-	-	1	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

Chapter – II
Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

Chapter – III
Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48.

Chapter – IV
Statements of basic knowledge - Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

Chapter – V
Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Reading:

1	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit, Sansthanam, New Delhi.

Web resource:

1	NTPEL:http://nptel.ac.in/downloads/109104115

AC 037	CONSTITUTION OF INDIA					
(AUDIT COURSE - II)						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	The history of Indian Constitution and its role in the Indian democracy.
2	Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3	Have knowledge of the various Organs of Governance and Local Administration.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the making of the Indian Constitution and its features.
CO-2	Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
CO-3	Have an insight into various Organs of Governance - composition and functions
CO-4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
CO-5	Understand Electoral Process, special provisions.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	-	-	-	-	-	1
CO-2	-	-	-	-	-	1
CO-3	-	-	-	-	-	1
CO-4	-	-	-	-	-	-
CO-5	-	-	--	-	-	1

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter – I
History of making of the Indian constitutions: History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

Chapter – II
Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality,

Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties

Chapter – III
Organs of Governance": Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

Chapter – IV
Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

Chapter – V
Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1	The Constitution of India", 1950 (Bare Act), Government Publication
2	Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3	M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014
4	D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web resource:

1	http://www.nptel.ac.in/courses/103107084/Script.pdf

AC038	PEDAGOGY STUDIES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2	Identify critical evidence gaps to guide the development.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
CO-2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO-3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1		1		1	
CO-2					1	
CO-3	1	1	1		1	

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Chapter - I

Introduction and Methodology:

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

Chapter - II

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education

Chapter - III
• Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school • Curriculum and guidance materials best support effective pedagogy? • Theory of change. • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies

Chapter - IV
• Professional development: alignment with classroom practices and followup support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes

Chapter - V
• Research gaps and future directions • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact

Suggested Reading :

1	Ackers J, Hardman F (2001) *Classroom interaction in Kenyan primary schools*, Compare, 31 (2): 245-261.
2	Agrawal M (2004) *Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies*, 36 (3): 361-379.
3	Akyeampong K (2003) *Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1*. London: DFID.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) *Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?* International Journal Educational Development, 33 (3): 272–282.
5	Alexander RJ (2001) Culture and pedagogy: *International comparisons in primary education*. Oxford and Boston: Blackwell.
6	Chavan M (2003) *Read India: A mass scale, rapid, 'learning to read' campaign*.
7	www.pratham.org/images/resource%20working%20paper%202.pdf.

CE281	MAJOR PROJECT- PHASE-I					
Pre-requisites			**L**	**T**	**P**	**C**
			6	-	-	10
Evaluation	**SEE**	-	**CIE**		100 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion of literature survey.
3	Discussion of methodology for the research work

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identification of the objectives for the particular research problem. (10 marks)
CO-2	Ability to update the latest **literature** in chosen area of research & establishment of scope pf work (20 m)
CO-3	Development of the methodology and perform analytical and /or experimental studies. (20 marks)
CO-4	Preparation of technical report (40 marks)
CO-5	Ability to justify the methodology of the chosen research problem (20 marks)

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	1	1	1	2		-
CO-2	1	1	2	2	2	-
CO-3	1	2	-	2	1	-
CO-4	-	1	-	-	3	2
CO-5	2	1	-	2	1	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Each student will be attached to a faculty member/supervisor for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the supervisor. At the end of the semester student will submit the report on the work done and submit to the supervisor. Student shall present his/her work before the committee constituted by HoD and BOS. The committee consists of Supervisor and two examiners. The sessional marks will be awarded jointly by these examiners based on the report, presentation and viva voice

SEMESTER-IV

CE282	MAJOR PROJECT- PHASE-II					
Pre-requisites			**L**	**T**	**P**	**C**
			32	-	-	16
Evaluation	**SEE**	-	**CIE**		200 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion and critical appraisal of literature review.
3	Implementation of Methodology for the research problem

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identification of methods and/or materials to carry out the analytical/experimental/simulation analysis for the selected research problem (20 marks)
CO-2	Analysis of data, development of models, and offer solutions to the research problem (20 marks)
CO-3	Analyse and interpret the results to draw valid conclusions (20 marks)
CO-4	Preparation of dissertation report (20 marks)
CO-5	Ability to defend the work and possible publication (20 marks)

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO6**
CO-1	3	1	2	2	1	1
CO-2	1	3	-	3	-	1
CO-3	--	2	1	2	-	1
CO-4	--	--	--	1	3	2
CO-5	--	--	--	3	2	2

Correlation rating : Low / Medium / High : 1 / 2 / 3 respectively.

Each student will be attached to a faculty member/supervisor for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the supervisor. At the end of the semester student will write the report on the

work done and submit to the supervisor. Student shall present his/her work before the committee constituted by HoD and BOS. The committee consists of Supervisor and two examiners. The dissertation evaluation is carried out in two stages each of which is 50 marks. The internal evaluation score will be awarded jointly by these examiners including supervisor based on the report, presentation and viva voice. Further, final presentation is evaluated for 100 marks which is evaluated by external examiner for 100 marks. Students are directed to submit plagiarism report containing less than 30% similarity index.