Shri Guru Gobind Singhji Institute of Engineering &Technology, Nanded-431 606.
Department of Civil Engineering

M. Tech. Civil Engineering (Water Management)

Teaching Scheme from Academic Year (2018-19)

Semester- I

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1	Core 1 PCC-WM501	Numerical Methods	3	0	2	**4**
2	Core 2 PCC-WM502	Surface Water Hydrology	3	1	0	**4**
3	Core 3 PCC-WM503	Groundwater Engineering	3	0	0	**3**
4	PEC-WM504-506	Program Specific Elective-I	3	1	0	**4**
	PEC-WM504	Irrigation Water Management				
	PEC-WM505	Advanced Hydraulics				
	PEC-WM506	Participatory Approach to Water Management				
5	PEC-WM507-509	Program Specific Elective-II	3	1	0	**4**
	PEC-WM507	Water Works Engineering				
	PEC-WM508	Remote Sensing and Geospatial Applications				
	PEC-WM509	Environmental Impact Assessment				
6	OEC-8AA	Open Elective	3	0	0	**3**
7	AUD-9@	Audit Course II (Optional)	2	0	0	**0**
					Sub Total	**22**

Semester- II

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1	Core 4 PCC-WM510	Water Resources Systems	3	1	0	**4**
2	Core 5 PCC-WM511	Hydraulic Structures	3	1	0	**4**
3	PEC-WM512-514	Program Specific Elective-III	3	1	0	**4**
	PEC-WM512	Climate Change and Sustainable Development				
	PEC-WM513	River Basin Organization				
	PEC-WM514	Water Resources Economics				
4	PEC-WM515-517	Program Specific Elective-IV	3	0	2	**4**
	PEC-WM515	Irrigation Engineering				
	PEC-WM516	Soft Computing Techniques				
	PEC-WM517	Watershed Management				
5	MCC-590	Research Methodology and IPR	2	0	0	**2**
6	MAC-591	English for Research Paper Writing	2	0	0	**0**
7	SEM-WM518	Mini Project & Seminar	0	0	4	**2**
					Sub Total	**20**

Semester- III

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1		Dissertation Phase –I	0	0	28	**14**

Semester- IV

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1		Dissertation Phase –II	0	0	28	**14**
					Total	**70**

List of Open Elective Courses	List of Audit Courses
OEC-801 Business Analytics	AUD-901 Project Management
OEC-802 Industrial Safety	AUD-902 Disaster Management
OEC-803 Operations Research	AUD-903 Sanskrit for Technical Knowledge
OEC-804 Cost Management of Engineering Project	AUD-904 Value Education
OEC-805Composite Materials	AUD-905 Constitution of India
OEC-806 Waste to Energy	AUD-906 Pedagogy Studies
	AUD-907 Stress Management by Yoga
	AUD-908 Personality Development through Life Enlightenment Skills

EXAMINATIONS

Examination system: Students are informed to see the examination scheme given in the rules and regulation book published by the institute.

PCC-WM501	NUMERICAL METHODS	L:03, T:0, P:02	Credits: 04

Course Objectives:

i) To provide basic knowledge of various numerical methods
ii) The methods include: root-finding, elementary numerical linear algebra, solving systems of linear equations, curve fitting, and numerical solution to ODE and PDE.
iii) The students would apply the concepts of numerical methods for solving various problems using MATLAB and/or Microsoft Excel /C programming

Unit I **(**7hrs)
Modeling, Computers and error analysis: Mathematical modeling and engineering problem solving. Role of computers and software. Approximations and errors. Significant figures, accuracy and precision, Errors, round-off and truncation errors, error propagation. Numerical differentiation and integration.

Unit II **(**7hr)
Curve fitting- Principle of least square, Linear, Laws reducible to the linear, fitting of the other curves.

Unit III (8hrs)
System of linear, Cramer's rule, Matrix inversion method, Gauss elimination method, Gauss-Jordan method, Factorization methods. Iterative methods, nonlinear algebraic equation

Unit IV (9hrs)
Ordinary differential equations- IVP methods like Picard's method, Taylor's series method, Euler's and modified Euler's method, R-K methods, predictor corrector method, Simultaneous first ODE, second order ODE, BVP methods.

Unit V (8hrs)
Partial differential equations- Different schemes, implicit and explicit schemes, Accuracy convergence and stability, Method of characteristics.

Unit VI (5hrs)
Convection and diffusion equation, Navier-Stokes equation, Finite difference method: solution to steady and unsteady flows Ground water flow problems, pollutant dispersion, flood wave propagation, tidal model, etc

Practical:
Student are expected develop C/C++/MATLAB/EXCEL programs for various numerical techniques mentioned in syllabus. Min of 8 programs should be developed.

Course Outcomes:
At the end of this course, the students are expected to

i) demonstrate understanding of common numerical methods and its use to obtain approximate solutions to otherwise intractable mathematical problems

ii) understand the different numerical methods to solve the algebraic equations and to solve system of linear and non linear equations
iii) understand the different numerical methods for regression, solving set of ordinary differential equations and solving of partial differential equation.
iv) be familiar with programming with MATLAB/ EXCEL/ C-programming

Reference Books:

1. Numerical Methods for Engineers by Chapra S.C and Canale R.P., McGraw Hill publications
2. Numerical methods in Engineering by Amir Wadi Al-Khafaji, J.R. Tooley, HRW practice Publication
3. Numerical Methods for Scientific and Computations by M.K. Jain et al, Wiley Eastern Engineering Publication.
   Introduction to Methods of Numerical Analysis by S.S. Sastry, Prentice Hall, New Delhi..
4. Computational Fluid Flow and Heat Transfer by Murlidhar K and Sundararajan T, Narosa Publishing House.

PCC-WM502	SURFACE WATER HYDROLOGY	L:03, T:1, P:0	Credits: 04

Course Objectives:

i) To train students in surface water hydrology as a prerequisite for water resource management.
ii) To impart in-depth knowledge of hydrologic processes, data collection and management, and estimation of parameters.
iii) To develop students for application of concepts and methods of hydrology to field problems.

Unit I **(**8hrs)

Subject matter and necessity of hydrology, hydrologic cycle, hydrologic processes, water budget equation. Precipitation-its forms and weather systems, measurement of precipitation, missing precipitation data, consistency of data, presentation of data, mean depth of rainfall over an area, probable maximum precipitation, depth-area-duration relationships, and maximum intensity-duration-frequency relationships.

Unit II **(**8hrs)

Evaporation process, factors affecting evaporation rate, measurement of evaporation rate, estimation of evaporation- empirical and analytical methods, reservoir evaporation and its reduction. Transpiration, evapotranspiration, measurement and estimation of evapotranspiration rate, Penman equation.

Unit III **(**7hrs)

Infiltration- process, factors affecting, measurement of average infiltration rate, Horton's infiltration models and equations, infiltration indices.

Unit IV **(**11hrs)

Runoff – components, factors affecting, basin yield, rainfall-runoff models, flow duration

curve, flow mass curve, droughts. Hydrographs – factors affecting flood hydrographs, components of hydrograph, base flow separation, unit hydrograph theory, derivation of unit hydrograph, unit hydrographs of different durations- S curve method, distribution graph, synthetic unit hydrograph, instantaneous unit hydrograph.

Unit V **(**6hrs)
Floods, methods estimation of magnitude of flood peak, flood frequency studies, Gumbel's method, design flood.

Unit VI **(**5hrs)
Flood routing – basic equations, reservoir routing- modified Pul's method, channel routing- Muskingham method.

Course Outcomes:

After completing this course the students should be able to:

i) Gain the knowledge about interrelationship of various components of the hydrologic cycle and their significance with reference to water resource management.
ii) Understand the concept of water budgeting and apply the water budget equation to a catchment and/or water body to carry out water availability studies.
iii) Analyze and estimate the abstractions from precipitation to compute runoff.
iv) Prepare the data requirement and outline for hydrological studies for runoff estimation through hydrograph analysis.
v) Apply methods of estimation for flood, and basic equations for reservoir routing.

Text and Reference Books:

1. Handbook of Applied Hydrology by V.T. Chow, McGraw Hill Publication, New York.
2. Engineering Hydrology by K. Subramanya, Tata McGraw Hill, New Delhi.
3. Hydrology for Engineers by Linsley, Kohler and Paulhus, McGraw Hill Pub, NY.
4. Engineering Hydrology by CSP Ojha, Berndtsson and P. Bhunya Oxford University Press.

PCC-WM503	GROUND WATER ENGINEERING	L:03, T:0, P:0	Credits: 03

Course Objectives:

i) Students will be exposed to ground water, hydraulics of ground water
ii) To study the groundwater exploration techniques for effective utilization
iii) To assess and simulate groundwater potential and quality using physical, electric analog and numerical models.
iv) To study aquifer remediation techniques

Unit I: **(**7hrs)
Darcy's law, Determination of Hydraulic Conductivity, Storage Coefficient, Transmissivity, Effective porosity

Unit II: **(**8hrs)
Derivation of general differential equation for groundwater flow, Boundary conditions.

Unit III: **(**7hrs)
Steady radial flow towards a well, Unsteady radial flow to well, Pumping tests.

Unit IV: **(**8hrs)
Analytical solution, Flow net analysis, Physical models, Electrical analog models for solution of groundwater flow equation.

Unit V: **(**8hrs)
Hydrodynamic dispersion, Solution of solute transport equation: Numerical methods.

Unit VI: **(**7hrs)
Artificial groundwater recharge, Conjunctive use system.

Course Outcomes:
At the end of this course, the students are expected to

i) understand the porous medium properties that control groundwater flow and transport
ii) apply groundwater flow equations to confined and unconfined aquifers
iii) to provide students with exposure to the systematic methods for solving engineering problems in groundwater engineering.
iv) compare methods for solving groundwater flow equations under a variety of situations,

Text and Reference Books:

1. Groundwater by Raghunath, Wiley Eastern publication.
2. Dynamics of Fluids in Porous Media by Bear J., (1972), Elsevier Publications Co. NY
3. Numerical Methods in Groundwater by A.K. Rastogi, Hydrology
4. Groundwater Hydrology by D.K. Todd, (1980), John Wiley & Sons, NY

PEC-WM504 **PEC-WM505** **PEC-WM506**	**PROGRAM SPECIFIC ELECTIVES-I**	**L:03, T:1, P:0**	**Credits: 04**

PEC-WM504	**IRRIGATION WATER MANAGEMENT**	**L:03, T:1, P:0**	**Credits: 04**

Course Objectives:
i) To expose the students the various principles of irrigation methods
ii) To inculcate the different types of irrigation systems and their performance based on service oriented approach.

Unit I **(**8hrs)
Irrigation development in India, Importance of Irrigation in Agriculture, Historical evolution of irrigation in India, Irrigation development during pre-colonisation, Colonisation and post-colonization, Different types of Irrigation prevalent in India: Warabandi, Shejpali and South Indian systems, Focus of Irrigation in India, Command area development approach and farmers participation.

Unit II **(**7hrs)
Irrigation systems and performance indicators, Systems classification, Institutions for irrigation management–Diagnostic Analysis of Irrigation Systems, Rehabilitation and modernization,

Performance indicators, Improving system performance, Conjunctive management, constraints faced.

Unit III **(**7hrs)

Main system management, Main system components, Reservoir allocation rule, Operating rule and optimization methods to improve main system performance, irrigation scheduling, Constraints.

Unit IV **(**7hrs)

Command area development and participatory irrigation management, Command area development principles – Participatory Irrigation Management and Irrigation management transfer, Case studies, Constraints.

Unit V **(**7hrs)

Irrigation policy and institutions, Present status of irrigation policy and institutions, Irrigation related conflicts,

Unit VI **(**7hrs)

Institutional transformation needed, Constraints in effecting institutional transformation, Irrigation financing, Water pricing, Water market, Policy changes.

Course Outcomes:

i) understand an irrigation system, its components, its performance, and management of irrigation complexities to tackle different issues.
ii) acquire knowledge about the need for participatory approach and irrigation management transfer along with irrigation policy and institutional aspects.

REFERENCES:

1. Rakesh Hooja, Management of Water for Agriculture: Irrigation, Water sheds and Drainage" Rawat Publications, New Delhi, 2006.
2. Kijne, J.W., Barker, R and Molden, D ,"Water Productivity in Agriculture; Limits and Opportunities for improved" CABI Publishing, Walling ford, U.K, 2003.
3. Giodano.M and Villbolth K.G, "The Agricultural Ground Water Revolution -Opportunities and threats to development" CABI Publishing, Walling ford, U.K, 2007.

PEC-WM505	ADVANCE HYDRAULICS	L:03, T:0, P:0	Credits: 03

Course Objectives:

i) To identify and define fundamental concepts in hydraulics;
ii) To analyse channel system performance and characteristics;
iii) To study characteristics of different fluid flows;

Unit I **(**8hrs)

Basic concepts: Energy and momentum equation and their application. Critical flow, channel controls, and transitions. Uniform flow and flow resistance, sheet flow; surface roughness, theoretical uniform flow equations;

Unit II **(**7hrs)

Concepts of boundary layer, boundary layer characteristics, laminar boundary layer, turbulent boundary layer, boundary layer separation and it's control.

Unit III **(**8hrs)

Instability of uniform flow; Gradually varied flow; Flow profile classification and

computation methods; Flow profiles in natural channels, Flow Profiles in Divided Channels, Hydraulic Jump, Jumps on a Sloping Floor.

Unit IV **(**7hrs)

Spatially varied flow, SVF with Increasing Discharge, SVF with Decreasing Discharge, Side Weir, Bottom Rack

Unit V **(**8hrs)

Unsteady flow: Continuity equation, Dynamic equation; Wave propagation; Method of characteristics; Rapidly varied unsteady flow; Surges; Dam-break problems

Unit VI **(**7hrs)

Dispersion in open channels; Properties of sediment, Sediment movement; tractive force; Bed load theory; Suspended load theory; Estimation of transported sediment.

Course Outcomes:

At the end of this course, the students are expected to

i) become familiar with open channel cross sections, pressure distribution, sediment transport.
ii) determine water surface profiles for gradually varied flow in open channels.
iii) analyze and design a field open channel system using modern engineering software.

Text and Reference Books:

1. Open Channel Hydraulics by V.T. Chow. McGraw Hill Publication.
2. Mechanics of Sediment Transportation and Eastern Alluvial Stream Problems by Garde, Ranga Raju; Wiley Publication.
3. Flow through Open Channel by K.S. Ranga Raju. TMH Ltd. New Delhi.
4. Engineering Hydraulics by Hunter Rouse
5. Hand Book of Applied Hydraulics by Calvin Victor Davis and Kenneth E Sorensen

PEC-WM506	PARTICIPATORY APPROACH TO WATER MANAGEMENT	L:03, T:1, P:0	Credits: 04

Course Objectives:

i) To study the principles of participatory management with reference to irrigation system model
ii) To understand the role of stakeholders and study the methods of involving stakeholders in improving performance of irrigation system

Unit I **(**8hrs)

Principles of management and its functions, management by objectives, Water laws, common property resources, ground water legislation, MWRRA 2005,

Unit II **(**8hrs)

Irrigation act and CADA act in various states of India. Irrigation system model, irrigation system as socio technical enterprise. Organizational and institutional bottlenecks,

Unit III **(**7hrs)

Information and communication system. Beneficiary's participation, canal committees, water use cooperative society and it's functions.

Unit IV **(**8hrs)

Incentives for WUA, Status of PIM in India, Equity and social justice in water management.

Unit V **(**7hrs)

Dynamics of social change due to irrigation, farmers organization.

Unit VI **(**7hrs)

Technology transfer methods. Communication, adoption & diffusion, reacting to people and motivation.

Course Outcomes:

At the end of this course, the students are expected to

i) understand suitability and viability of the PIM approach in improving the efficiency and performance of irrigation systems, including the suitability of various WUA models
ii) conceptualize the involvement of farmers in operation, management, and maintenance of the irrigation systems at secondary and tertiary levels through WUAs
iii) quantify the impacts of PIM w.r.t. irrigation system management, WUAs, the irrigation subsector organizations, and the emerging private-sector service providers

Text and Reference Books:

1. PIM-Paradigm for 21st century Volume I and II — by L. K. Joshi and Rakesh Hooja, India NPIM New Delhi
2. Farmer's managed irrigation system — by R.K. Patil & S.N. Lele, SOPECOM Pune
3. Handbook on PIM compiled — by David Groenfeldt, India NPIM , New Delhi
4. WALMI publication on PIM — WALMI, Aurangabad

PEC-WM507 **PEC-WM508** **PEC-WM509**	**PROGRAM SPECIFIC ELECTIVES-II**	**L:03, T:1, P:0**	**Credits: 04**

PEC-WM507	**WATER WORKS ENGINEERING**	**L:03, T:1, P:0**	**Credits: 04**

Course Objectives:

i) To understand the role of economics in making decisions in water works
ii) To design and analyze the treatment of waste water for its possible reuse in the domestic sector
iii) To study and design site specific rainwater harvesting systems to develop sustainable system of water supply
iv) To understand the basics of water audit and use of equipments for leak detection in water supply system

Unit I **(**8hrs)

Integrated approach to water supply and sanitation, Million Development goals, Estimation of demand, Demand side management, Sources of water for increasing population.

Unit II **(**7hrs)

Economics of water supply and pricing of water, procedure of fixing water charges,Basic design considerations, Pre design report.

Unit III **(**8hrs)

Design of water treatment plant based on raw water quality parameters. High service pumps and distribution system. Design of distribution system.

Unit IV **(**7hrs)

Residual processing, recovery of chemicals. Filter backwash, Ultimate disposal, Operation maintenance and troubleshooting.

Unit V **(**8hrs)

Water audit, procedure, lessons drawn to improve w/s. Losses and leakages, Reasons, Detection, Measurement and measures to control. Management, legal and institutional aspects.

Unit VI **(**7hrs)

Rain water harvesting system design, decentralized system, small isolated systems for apartments and industries

Course Outcomes:

At the end of this course, the students are expected to

i) devise cost effective water collection and distribution systems
ii) understand the principals of water treatment and design treatment units
iii) develop skills to solve practical problems in areas of water treatment and management
iv) make an immediate and real contribution to water sector businesses and organisations
v)

Text and Reference Books

1 Water treatment plant design by ASCE and AWWA
2 Water treatment principle and design by J. M Montgomery
3 IWWA data book
4 Water works engineering by Qasim, Motley and Zhu. Prantice Hall of India Pvt. Ltd. Publication, 2004

PEC-WM508	REMOTE SENSING AND GEOSPATIAL APPLICATIONS	L:03, T:1, P:0	Credits: 04

Objectives:

i) To study the principles of remote sensing and GIS for water resource management
ii) To study the applications of RS and GIS in water management and to use the software available for analysis

Unit I **(**7hrs)

Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.

Unit II **(**7hrs)
Platforms and their characteristics, Fundamentals of processing and analysis of remotely sensed data by Analog, Digital and hybrid systems and the equipments required, Digital analysis of CCTS, Supervised and unsupervised classification techniques.

Unit III **(**7hrs)
Satellite Data analysis, Visual interpretation, Digital image processing, Image preprocessing, Image enhancement, Data Merging.

Unit IV **(**8hrs)
Definition – Basic components of GIS, Map projections and co-ordinate system, Spatial data structure: raster, vector, Spatial Relationship, Topology, Geodatabase models: hierarchical, network, relational, object oriented models, Integrated GIS database, common sources of error, Data quality: Macro, Micro and Usage level components, Meta data, Spatial data transfer standards.

Unit V **(**8hrs)
Thematic mapping – Measurement in GIS: length, perimeter and areas, Query analysis, Reclassification, Buffering, Neighborhood functions, Map overlay: vector and raster overlay – Interpolation, Network analysis, Digital elevation modelling. Analytical Hierarchy Process, Object oriented GIS – AM/FM/GIS – Web Based GIS

Unit VI **(**8hrs)
Spatial data sources, 4M GIS approach water resources system, Thematic maps, Rainfall-runoff modelling, Groundwater modeling, Water quality modeling, Flood inundation mapping and Modelling, Drought monitoring, Cropping pattern change analysis, Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation.

Course Outcomes:
At the end of this course, the students are expected to

i) understand remote sensing sensors and platforms, their properties and calibration
ii) acquire skills in handling instruments, tools, techniques and modeling while using remote sensing technology
iii) develop abilities in RS/GIS from data acquisition and processing through to effective display of results
iv) contribute effectively to use of image analysis and GIS techniques in an industrial/research context

Text and Reference Books:
1. Remote Sensing Methods and Application by R. Michael Horti, Wiley Interscience Publications.
2. Introduction to Environmental Remote Sensing by Barett. E.C. and Curtis L.F., Chapman and Hall, London.
3. Remote sensing and Image Interpretation by Lillesand T.M. and Kiefer R.W., Wiley, New York

PEC-WM509	ENVIRONMENTAL IMPACT ASSESSMENT	L:03, T:0, P:0	Credits: 03

Course Objectives:

1) To understand the role of environmental impact assessment in environmental risk

evaluation

2) To evaluate systems for more tangible risk evaluation through direct measurement of environmental indicators

Unit I **(**8hrs)

Introduction, definitions and concepts, rationale and historical development of Environmental Impact Assessment **(EIA)**, EIA for civil engineers.

Unit II **(**8hrs)

Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration. Pertinent institutional information, unique pollution problems, existing visual quality, public participation techniques.

Unit III **(**8hrs)

Measurement of environmental impact, organization, scope and methodologies of EIA pertinent environmental factors. Six generic steps, descriptive checklists, simple interaction matrix, stepped matrix, uniqueness ratio, habitat evaluation system.

Unit IV **(**7hrs)

EIA Regulations in India, TOR for Hydropower Projects and other projects. Case studies from hydropower projects, hazardous industries and mining.

Unit V **(**7hrs)

Definitions and concepts of environmental audit, partial audit, compliance audit, methodologies and regulations.

Unit VI **(**7hrs)

Energy foot printing, Food foot printing and Carbon foot printing. GHG emissions, global warming, climate change and Carbon credits, CDM, Initiatives in India; Sustainable development; Future scenarios.

Course Outcome :

i) To develop an understanding of current EIA methods and the techniques and tools used
ii) To develop an understanding of current assessment methods and legislation
iii) To understand the climate change phenomenon and its related issues on water, irrigation and its social implications.
iv) To develop an understanding of current environmental monitoring systems
v) To apply knowledge acquired to the process of environmental impact modelling and prediction as a design tool with application to a number of case studies

Text and Reference Books:

1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997. 2. P. Judith and G. Eduljee,
2. Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994. 3. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000. 4.
3. C. H. Eccleston, Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000. 5.
4. R. Welford, Corporate Environmental Management - Systems and Strategies, Universities Press, 1996. 6.

5. K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997. 7.
6. The Economist Intelligence Unit, Best Practices - Environment, Universities Press, 1993. 8.
7. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.

SEMESTER-II

PCC-WM510	WATER RESOURCES SYSTEMS	L:03, T:1, P:0	Credits: 04

Objectives:

i) To understand the process of water resource planning with reference river basin/watershed as planning unit
ii) To understand and apply principles of economics to feasibility studies
iii) To study methods and techniques of evaluation of water resources projects
iv) To study the environmental impacts of water resources projects

Unit I **(**8hrs)
Planning and decision making process, Systems approach to water resource planning, Water as economic commodity, Principles of economics, discounting techniques,.

Unit II **(**7hrs)
Objective function, Maxima, minima and saddle points, convex and concave functions, Constrained and unconstrained optimization using calculus, Lagrange multipliers, Kuhn-Tucker conditions.

Unit III **(**8hrs)
General form of LP, Standard and Canonical forms of LP, Elementary transformations, Graphical method, Feasible and infeasible solutions, Simplex method, Dual and sensitivity analysis, LP problem formulation, Reservoir sizing and Reservoir operation using LP.

Unit IV **(**7hrs)
Price theory, Resource allocation, project optimality conditions, Cost benefits studies, Role of benefit cost parameters in project selection, Economic feasibility tests.

Unit V **(**8hrs)
Decision making under uncertainty and risk, Cost benefit studies of single and multipurpose projects, Economic planning, capacity expansion.

Unit VI **(**7hrs)
Multi-objective planning, Methods of analysis, Stakeholders' participation, Preparation of feasibility report, interstate water disputes, international development on water transfer, Concept of IWRM.

Course Outcomes:
At the end of this course, the students are expected to

i) gain knowledge about economic aspects of water and also gain a broader understanding of the complexities of dealing with water resources problems
ii) acquaint themselves in the allocation of resources and financial analysis in the water sector
iii) take a holistic approach in examining the whole system of variables and their interactions and impacts

Text and Reference Books:

1. Water Resources Project Economics by Kuiper, Buttersworth, London.
2. Water Resources System Planning and McGraw Hill Management by M.C. Chaturvedi, (1987), Tata New Delhi.

PCC-WM511	HYDRAULIC STRUCTURES	L:03, T:1, P:0	Credits: 04

Objectives:

i) To introduce the student to developments in design of hydraulic structures
ii) To develop understanding of the basic principles and concepts of analysis and design of hydraulic structures
iii) To formulate and solve multivariable hydraulic design problems

Unit I **(**4hrs)
Spillways: Types, general layout elements & basic principles of Hydraulic design.

Unit-II **(**4hrs)
Spillway gates: types such as tainter, drum, vertical left, automatic. General layout, basic principles of design

Unit III **(**8hrs)
Determination of Spillway capacity: rating curves, spillway design, flood hydrographs, routing of floods, flood forecasting.

Unit IV **(**7hrs)
Energy dissipaters: types, general layout, basic concept of hydraulic design outlet through dams: types, layout, general arrangements & components.

Unit V **(**3hrs)
Transitions: Transitions in open channels and closed conduits, design considerations.

Unit VI (4 hrs)
Design of large dams, Arch and Buttress dam, Reservoir and its planning.

Course Outcomes:
At the end of this course, the students are expected to

i) judge suitable sites for locating different hydraulic structures
ii) estimate forces to be considered for design of hydraulic structures
iii) understand the recommendations made in IS Code
iv) analyze and design different hydraulic structures

Text and Reference Books:

1. Open Channel Hydraulics by Chow V.T.
2. Design of Small Dams USBR Oxford IBH Publishing Company Mumbai
3. Irrigation & Hydraulic Design Vol . I, II, & III by Leliavisky S
4. Hydraulic Structures by Grishing, Mir Publishers, Moscow (USSR)

PEC-WM512 **PEC-WM513** **PEC-WM514**	**PROGRAM SPECIFIC ELECTIVES-III**	**L:03, T:1, P:0**	**Credits: 04**

PEC-WM512	**CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT**	**L:03, T:1, P:0**	**Credits: 04**

Objectives:

i) To introduce students to the policy debates and responses created by climate change
ii) To develop understanding of the basic principles and concepts of sustainable development
iii) To provide students with the opportunity to examine global issues in a very specific and local context.

Unit I **(**8hrs)
A general overview of climate science and impacts, highlighting the current state of knowledge and remaining uncertainties.

Unit II **(**7hrs)
Carbon emissions reduction options: mitigation and energy system changes; efficiency options; and "end-of-pipe" solutions (e.g. carbon capture).

Unit III **(**8hrs)
Carbon economics, covering the various ways in which the externality of greenhouse gas emissions can be monetized, including taxes, cap and trade systems, and international transfers.

Unit IV **(**7hrs)
Renewable/non-fossil energy sources might help mitigate the climate problem- the focus will be innovation and diffusion of on wind, solar and nuclear power

Unit V **(**8hrs)
Photosynthesis – radiation and its parameters, Solar radiation, Spectrum and effects; Energy balance at the level of a leaf and ecosystem, Crop production – canopy structure, radiation use efficiency, factors determining productivity.

Unit VI **(**7hrs)
Sustainability – Ecosystem services, Millennium ecosystem assessment, Ecological foot print, Energy, Gaia, Climate Change and Sustainability -Natural Resources, Energy & Society at various space and time scale.

Course Outcomes:
At the end of this course, the students are expected to

i) Apply basic scientific knowledge about the climate systems and human impacts
ii) Demonstrate working familiarity with technological approaches to the climate change mitigation (including renewables and nuclear technologies)
iii) Explain basic economic concepts in climate policy
iv) Apply course concepts to 'real-world' cases of climate policy
v) Analyze the synergies and trade-offs between development and climate policy

Text and Reference Books:

i) Climate Change 2014*: Impacts, Adaptation, and Vulnerability*, IPCC
ii) Stephen Peak and Joe Smith, *Climate Change: From science to sustainability*, Oxford University Press
iii) *Climate Change 2013: The Physical Science Basis*, IPCC.
iv) *Kevin E Trenberth:* Climate System Modeling, *Cambridge University Press*
v) *Kendal McGuffie,* Ann Henderson-Sellers: A Climate Modeling Premier, *Wiley*

PEC-WM513	RIVER BASIN ORGANIZATION	L:03, T:1, P:0	Credits: 04

Objectives:

i) To learn how to estimate availability of water resources in a river basin
ii) To learn to work out current and future water requirements for developing and maintaining sustainable livelihoods in the Project region
iii) To get awareness about various existing river basin organizations across the globe
iv) To learn about efficient and integrated use of land and water for sustainable agriculture development

Unit I **(**7hrs)
River basin as unit of planning, Water availability studies and demand assessment at basin level, IWRM approach.

Unit II **(**8hrs)
Basic functions for water resources management, Water management objectives, Institutional arrangement for performing the functions, Basic indicators at basin level to measure progress and performance, Criteria for developing indicators.

Unit III **(**4hrs)
Stakeholder participation, Water allocation, Water resources systems analysis,

Unit IV (4 hrs)
Pollution management at basin level, Planning for pollution control.

Unit V **(**7hrs)
Monitoring of water resources systems: Pollution, quality and use.

Unit VI **(**7hrs)
Economic and financial instruments for RBO, Basin planning process. Implementation of basin plan.

Course Outcomes:
At the end of this course, the students are expected to

i) undertake basin level study with understandings of the geography, meteorology, history of water use of the basin.
ii) learn about various approaches of river basin management that best fits to the basin.
iii) make effort for learning basin level water resources management with technical, and social aspects

Text and Reference Books:

1. IWRM for RBO UNDP manual
2. Integrated River Basin management through decentralization by Kemper, Karin, Springer publication

PEC-WM514	WATER RESOURCE ECONOMICS	L:03, T:0, P:0	Credits: 03

Objectives:

i) To learn about economic aspects of water and also gain a broader understanding of the complexities of dealing with water resources problems.
ii) To get awareness about allocation of resources and financial analysis in the water sector.
iii) To take a holistic approach in examining the whole system of variables and their interactions and impacts.

Unit I **(**7hrs)
Principles of Engineering Economics, mathematics of economic analysis, cash flow diagram, discounting factors and discounting techniques.

Unit II **(**8hrs)
Introduction to microeconomics, market economy and demand, price elasticity, market price determination, consumer demand, introduction to production theory.

Unit III **(**7hrs)
Welfare economics, social objectives, evaluation of social benefits and costs, regional development, discount rate.

Unit IV **(**8hrs)
Benefit-Cost analysis, feasibility tests, defining benefits and costs, direct and indirect benefits, primary and secondary benefits.

Unit V **(**7hrs)
Types of costs associated and induced costs, operation and maintenance costs.

Unit VI **(**8hrs)
Economic planning of projects, flood control, drainage, irrigation, water supply, hydropower and water quality control projects.

Course Outcomes:
At the end of this course, the students are expected to

i) Acquire knowledge about economic aspects of water and also gain a broader understanding of the complexities of dealing with water resources problems
ii) acquaint themselves in the allocation of resources and financial analysis in the water sector

i) Identify and evaluate the costs and benefits of water resources projects
ii) Perform socio-economic analysis to evaluate the intangible benefits and costs
iii) Analyze the economic feasibility of water resources development projects
iv) Apply principles of microeconomics for evaluating the demand and pricing of water related services

Text and Reference Books:

i) Griffin, R.C., Water Resource Economics, MIT Press, 2006
ii) James, D.G., and Lee, R.R., Economics of Water Resources Planning, McGraw Hill Publishing Co, N.York, 1979
iii) Kuiper, E., Water Resources Project Economics, Butterworth Pub. Co, London, 1971
iv) Merrett, S., Introduction to Economics of Water Resources: An International Perspective, Routledge Publishers, UK, 1997

PEC-WM515 **PEC-WM516** **PEC-WM517**	**PROGRAM SPECIFIC ELECTIVES-IV**	**L:03, T:0, P:2**	**Credits: 04**

PEC-WM515	**IRRIGATION ENGINEERING**	**L:03, T:0, P:2**	**Credits: 04**

Objectives:

i) Understand how to estimate the quantity of water required by crops using manual and computer methods.
ii) Be able to plan and design irrigation and drainage projects.
iii) Understand the computer applications in irrigation and drainage designs.
iv) Design channels and other irrigation structures required for irrigation, drainage, soil conservation, flood control and other water-management projects.

Unit I **(**6 hrs)
Introduction, objectives of irrigation, History of irrigation, Administration of irrigation projects, Planning of irrigation projects. Economics and financing of irrigation projects, Impact of irrigation on human environment.

Unit II **(**9 hrs**)**
Soil water relationship and Irrigation Techniques - Gravity Irrigation, Subsurface Irrigation, Sprinkler Irrigation and Drip Irrigation, Hydraulic design of Gravity, Sprinkler and Drip Irrigation system .

Unit III **(**3 hrs**)**
Tube well Irrigation, Lift Irrigation and their hydraulic designs.

Unit IV **(**8 hrs**)**
Assessment of irrigation water, Audit of irrigation water, Preparation of irrigation schedules based on crop water requirement-Infiltration, infiltrometer, ponding methods, soil water, tensiometers, neutron probe, time domain reflectometer, evapotranspiration, crop coefficient, leaf area index, FAO guide lines on evapotranspiration estimation.

Unit V **(**8 hrs**)**
Canal Design, linings and regulation works, operation and maintenance of canal system, canal automation.

Unit VI **(**6 hrs)
Drainage principles, need for drainage, steady state equations, Hooghoudt, Kirkham, Dagan and Ernst equations.

Course Outcomes:
At the end of this course, the students are expected to

i) understand the design concepts related to sprinkler and drip irrigation
ii) design various types and methods of irrigation using various design principals
iii) plan and design the drainage system in an efficient manner
iv) plan the irrigation project and apply the irrigation management techniques

Text and Reference Books:
1. Irrigation by Zimmerman, Wiley Toppan Pub.
2. Principles and practice of Irrigation Engineering by S.K. Sharma, S. Chand and Co. Ltd. New Delhi.
3. Irrigation Theory and practice by A.M. Michael, Vikas Publishing
4. Canal Automation CBIP Publication No. 238, New Delhi

PEC-WM516	SOFT COMPUTING TECHNIQUES	L:03, T:0, P:2	Credits: 04

Objectives:

i) To introduce the basics of soft computing techniques and illustrate its application for solving various problems in water resources engineering.
ii) To introduce the ideas of fuzzy sets, fuzzy logic
iii) To become familiar with neural networks
iv) To familiarize with genetic algorithms useful while seeking global optimum

Unit I : Artificial Neural Networks (8hrs)
Development of ANN, Types of ANN structure, Properties of Neural Network, Components of Neural Network, Neurons, Layers, Input and output weights, Threshold,

Unit II : **Artificial Neural Networks** (8hrs)
Types of transfer functions, Learning with neural network, Types of learning, Stability and convergence, Fundamentals of Error backpropagation learning, Generalized delta rule, EBP algorithm,

Unit III : **Artificial Neural Networks** (7hrs)
Data normalization, Selection of learning rate and momentum factor; Application of ANN in hydrology and water management problem

Unit IV : **Fuzzy Logic** (8hrs)
Introduction, fuzzy system, classical set and fuzzy sets, operation and properties of classical and fuzzy set. Classical relation and fuzzy relations, crisp relations, operations on fuzzy relations, various types of binary fuzzy relations, fuzzy relations equations,

Unit V : Fuzzy Logic **(**7hrs)
The extension principle and its applications, tolerance and equivalent relation, value assignment, application of fuzzy logic for various problems encountered in hydrology and water recourses management.

Unit VI : Genetic Algorithm (7hrs)
Introduction to fundamentals of techniques and applications of genetic algorithms.

Course Outcomes:
At the end of this course, the students are expected to

i) learn about soft computing techniques and their applications
ii) identify and select a suitable soft computing method to solve the problem; construct a solution and implement it
iii) analyze various neural network architectures and implement these to solve various problems
iv) analyze the fuzzy systems, genetic algorithms and their applications

Text and Reference Books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms — by S. Rajasekaran and G.A. Vijayalakshmi Pai, PHI publications.
2. Neural Networks: A Compressive foundation — by S. Haykin, McMillan Publications
3. Understanding neural networks and fuzzy S.T., logic basic concepts and applications (2000). — by Kartalopoulos Prentice Hall

PEC-WM517	WATERSHED MANAGEMENT	L:03, T:0, P:0	Credits: 03

Course Objectives:

i) To provide basic knowledge of soil and water conservation techniques
ii) To provide knowledge of watershed management

Unit I: Soil Erosion & Its Control (8hrs)

Basic concepts of soil erosion; Factors affecting soil erosion; Types of erosion: Water erosion, Wind erosion, Gully erosion and Stream bank erosion; Models for estimating soil erosion losses (USLE); Climate change and soil erosion risk; Soil erosion control structures and their design: Contour bunding, Graded bunding, Bench terracing and Contour trenching.

Unit II: Soil & Water Conservation (8hrs)

Need of soil and water conservation; Soil survey ; Water harvesting techniques: Farm Ponds & Percolation Tanks: Selection of site, Survey & Design; Design and construction of Cement Nalla Bandhara (CNB) structures.

Unit III: Hydrology of Watershed (7hrs)

Hydrological processes in watershed; Hydrologic Modeling of watershed; Estimation of peak design runoff rate: (Rational method and Curve number method).

Unit IV: Watershed Development & Management (7hrs)

Watershed development: Ridge to Valley Concept; Watershed characteristics; Watershed delineation; Land use capability classification.

Unit V: Irrigation System Management (8hrs)

Irrigation system management; Design of irrigation quality management system; Participative irrigation management.

Unit VI: Land Grading & Drainage (7hrs)

Land grading survey and design: (Plane and Profile methods); Drainage design criteria & drainage equations; Design , construction & maintenance of surface and subsurface drainage systems.

Course Outcomes:

At the end of this course, the students are expected to

i) demonstrate understanding of water harvesting techniques
ii) understand the different land grading and drainage methods
iii) be familiar with watershed development

References:

1. Fangmeier, W., Elliott, W.J., Workman, S., Huffman, R. and Schwab, G.O. 2005, Soil and Water Conservation Engineering, 5th Edition, Cengage Learning, Inc., Clifton Park, USA.
2. Murthy, V.V.N., 2002, Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
3. Suresh, R., 2004, Soil and Water Conservation Engineering, Standard Publishers, New Delhi.

Open Elective

OEC-801	BUSINESS ANALYTICS	L:03, T:0, P:0	Credits: 03

Course objectives:

1. To understand the role of business analytics within an organization.
2. To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. To use decision-making tools/Operations research techniques.
6. To mange business process using analytical and management tools.
7. To analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Syllabus:

Unit I:
Business analytics: Overview of business analytics, scope of business analytics, business analytics process, relationship of business analytics process and organization, competitive advantages of business analytics. statistical tools: statistical notation, descriptive statistical methods, review of probability distribution and data modeling, sampling and estimation methods overview.

Unit II:
Trendiness and regression analysis: Modeling relationships and trends in data, simple linear regression. important resources, business analytics personnel, data and models for business analytics, problem solving, visualizing and exploring data, business analytics technology.

Unit III:
Organization structures of business analytics, team management, management issues, designing information policy, outsourcing, ensuring data quality, measuring contribution of business analytics, managing changes. descriptive analytics, predictive analytics, predicative modeling, predictive analytics analysis, data mining, data mining methodologies, prescriptive analytics and its step in the business analytics process, prescriptive modeling, nonlinear optimization.

Unit IV:
Forecasting techniques: Qualitative and judgmental forecasting, statistical forecasting models, forecasting models for stationary time series, forecasting models for time series with a linear trend, forecasting time series with seasonality, regression forecasting with casual variables, selecting appropriate forecasting models. monte carlo simulation and risk analysis: monte carle simulation using analytic solver platform, new-product development model, newsvendor model, overbooking model, cash budget model.

Unit V:
Decision analysis: Formulating decision problems, decision strategies with the without outcome probabilities, decision trees, the value of information, utility and decision making.

Unit VI:
Recent trends in : Embedded and collaborative business intelligence, visual data recovery, data storytelling and data journalism.

Course Outcomes:

1. At the end of this course, students will be able to:
2. Demonstrate knowledge of data analytics.
3. Demonstrate the ability of think critically in making decisions based on data and deep analytics.
4. Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
5. Demonstrate the ability to translate data into clear, actionable insights.

References:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OEC-802	INDUSTRIAL SAFETY	L:03, T:0, P:0	Credits: 03

Course Syllabus:

Unit-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.

Unit-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 and its relation with replacement economy, service life of equipment.

Unit-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, i. screw down grease cup, ii. pressure grease gun, iii. splash lubrication, iv. gravity lubrication, v. wick feed lubrication vi. side feed lubrication, vii. ring lubrication, definition, principle and factors affecting the corrosion. types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: fault tracing-concept and importance, decision treeconcept, 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, i. any one machine tool, ii. pump iii. air compressor, iv. internal combustion engine, v. boiler, vi. electrical motors, types of faults in machine tools and their general causes.

Unit-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: i. machine tools, ii. pumps, iii. air compressors, iv. diesel generating (DG) sets, program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. repair cycle concept and importance

Reference:

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

OEC-803	OPERATIONS RESEARCH	L:03, T:0, P:0	Credits: 03

Course Syllabus:

Unit I:

Optimization techniques, model formulation, models, general L.R formulation, simplex techniques, sensitivity analysis, inventory control models

Unit II:

Formulation of a LPP - graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit III:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit IV:

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - probabilistic inventory control models - geometric programming.

Unit V:

Competitive models, single and multi-channel problems, sequencing models, dynamic programming, flow in networks, elementary graph theory, game theory simulation

Course Outcomes:

1. At the end of this course, students will be able to:
2. Apply the dynamic programming to solve problems of discreet and continuous variables.
3. Apply the concept of non-linear programming.
4. Carry out sensitivity analysis.
5. Model the real world problem and simulate it.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009.
5. Pannerselvam, Operations Research: Prentice Hall of India 2010.
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

OEC-804	COST MANAGEMENT OF ENGINEERING PROJECTS	L:03, T:0, P:0	Credits: 03

Course Syllabus:

Unit I:

Introduction and overview of the strategic cost management process.

Unit II:

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. 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 nontechnical activities. detailed engineering activities. 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.

Unit III:

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.

Unit IV:

Quantitative techniques for cost management, linear programming, PERT/CPM, transportation problems, assignment problems, simulation, learning curve theory.

References:

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 and Cost Accounting.
4. Ashish K. Bhattacharya, Principles and Practices of Cost Accounting A. H. Wheeler publisher.
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OEC-805	COMPOSITE MATERIALS	L:03, T:0, P:0	Credits: 03

Course Syllabus:

Unit-I:

Introduction: definition – classification and characteristics of composite materials. advantages and application of composites. functional requirements of reinforcement and matrix. effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Unit-II:

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, kevlar fibers and boron fibers. properties and applications of whiskers, particle reinforcements. mechanical behavior of composites: rule of mixtures, inverse rule of mixtures. isostrain and isostress conditions.

Unit-III:

Manufacturing of metal matrix composites: casting – solid state diffusion technique, cladding – hot isostatic pressing. properties and applications. manufacturing of ceramic matrix composites: liquid metal infiltration – liquid phase sintering. manufacturing of carbon – carbon composites: knitting, braiding, weaving. properties and applications.

Unit-IV:

Manufacturing of polymer matrix composites: preparation of moulding compounds and prepregs – hand layup method – autoclave method – filament winding method – compression moulding – reaction injection moulding. properties and applications.

Unit-V:

Strength: Laminar failure criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. laminate first play failure-insight strength; laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

References and Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley and Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OEC-806	WASTE TO ENERGY	L:03, T:0, P:0	Credits: 03

Course Syllabus:

Unit-I:

Introduction to energy from waste: classification of waste as fuel – agro based, forest residue, industrial waste - MSW – conversion devices – incinerators, gasifiers, digestors

Unit-II:

Biomass pyrolysis: pyrolysis – types, slow fast – manufacture of charcoal – methods - yields and application – manufacture of pyrolytic oils and gases, yields and applications.

Unit-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.

Unit-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.

Unit-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.

References:

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 and 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 and Sons, 1996.

Audit Course

AUD-901	PROJECT MANAGEMENT	L:02, T:0, P:0	Credits: 00

Course objective:

1. Understand the fundamental principles of Project management and also have a good knowledge of responsibilities of project manager and how to handle these.
2. To do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.
3. To highlight different techniques for software cost estimation and activity planning.

Course Syllabus:

Unit-I:

Project Management: Concept of Project Management, Principles of Project Management, Functions of Project Management: Planning, Organizing, Staffing, Directing & Controlling, Project Scope Verification , Functional & Matrix Organization Structure.

Unit-II:

Project Network Analysis: Project Network Diagram: Precedence Diagramming Method (PDM), Activity-on-Node (AON) & Arrow Diagramming Method (ADM), Work Breakdown Structure (WBS), Gantt Chart, Milestone Chart, Project Network Analysis (Critical Path Method and PERT), Cost Analysis of Project, Resource Allocation, Resource Smoothening & Leveling, Resource Histograms, Use of Computer Software (PRIMAVERA & MICROSOFT PROJECT) in Project Network Analysis.

Unit-III:

Project Network Case Studies: Thermal Power Project, Fertilizer Project, Turnkey Construction Project, Software Creation & Installation Project, Project Related to Mechanical Industry, Projects Related to Electronic & Communication Industry.

Unit-IV:

Project Economics & Project Value Analysis: Project Formulation, Project Plan, Project Appraisal Techniques: Net Present Value, Internal Rate of Return, Payback Period, Benefit Cost Ratio, Value Engineering job plan, Project Life Cycle Costs.

Unit-V:

Project Quality , Risk & Procurement Management: Project Quality Planning, Assurance & Control, Project Quality Management Techniques: Kaizen & Just-inTime, Total Quality Management, Risk-Management Plan, Uncertainty, Risk Factors and Risk Tolerances, Project Quantitative Risk Analysis (Monte Carlo Analysis & Decision Tree), Project Risk Monitoring & Control, Procurement Management Plan, Project Contract Administration.

Unit-VI:

Computerized Project Management: Project Information Cell, Management Information System, Software Project Management, Categorization of Software Projects , Project portfolio Management, Software Process and Process Models, Choice of Process Models: Mental Delivery, Rapid Application Development, Agile Methods, Extreme Programming, SCRUM, Software Estimation, Effort and Cost Estimation Techniques, COSMIC Full Function Points, COCOMO II A Parametric Productivity Model, Project Tracking, Software Configuration Management, Staffing Pattern, Methods of staff selection, The Oldham-Hackman job characteristic model.

Course Outcomes:

1. Understand the concepts and functions of project management.

2. Apply the project plan planning and monitoring techniques.
3. Analyze the project value, risk and quality.
4. Design and develop projects at each stage of the software development life cycle (SDLC).

References:

1. Chitkara K.K., Construction Project Management, Tata McGraw Hill Publications.
2. Barrie D.S. & Paulson B.C,Professional Construction Management,McGraw Hill.
3. R.Flagnan and G.Norman, Risk Managemnt & Construction, Blackwell Scientific Publishers.
4. L.W. Zimmwerman and G.D. Hart, Value Engineering, CBS Publishers.
5. Robert K. Wysocki “Effective Software Project Management” – Wiley Publication, 2011.
6. Walker Royce: “Software Project Management”- Addison-Wesley, 1998.

AUD-902	DISASTER MANAGEMENT	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Contents:

UNIT I:

Disaster: Definition, Factors And Significance; Difference Between Hazard and Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II:

Repercussions of disasters and hazards: economic damage, loss of human and animal life, destruction of ecosystem. Natural disasters: earthquakes, volcanisms, cyclones, Tsunamis, floods, droughts and famines, landslides and avalanches, man-made disaster: Nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts.

UNIT III:

Disaster prone areas in India study of seismic zones; areas prone to floods and droughts, landslides and avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami; post-disaster diseases and epidemics.

UNIT IV:

Disaster preparedness and management preparedness: monitoring of phenomena triggering a disaster or hazard; evaluation of risk: application of remote sensing, data from meteorological and other agencies, media reports: governmental and community preparedness.

UNIT V:

Risk assessment disaster risk: concept and elements, disaster risk reduction, global and national disaster risk situation. Techniques of risk assessment, global co operation in risk assessment and warning, people's participation in risk assessment. Strategies for survival.

UNIT VI:

Disaster mitigation meaning, concept and strategies of disaster mitigation, emerging trends in mitigation. Structural mitigation and non-structural mitigation, programs of disaster mitigation in India.

Suggested Readings:

1. R. Nishith, Singh A.K., "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep and Deep Publication Pvt. Ltd., New Delhi.

AUD-903	SANSKRIT FOR TECHNICAL KNOWLEDGE	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

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 and 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 Contents Outcomes:

At the end of the Course Contents students will be able to

1. Understanding basic Sanskrit language.
2. Ancient Sanskrit literature about science and technology can be understood.
3. Being a logical language will help to develop logic in students.
4.

Course Contents:

UNIT I:
Alphabets in Sanskrit.

UNIT II:
Past/Present/Future Tense.

UNIT III: Simple Sentences, Order.

UNIT IV:
Introduction of roots.

UNIT V:
Technical information about Sanskrit Literature.

UNIT VI:
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

Suggested reading:

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

AUD-904	VALUE EDUCATION	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

1. Understand value of education and self- development.
2. Imbibe good values in students.
3. Let the students know about the importance of character.

Course Contents Outcomes:

1. Knowledge of self-development.
2. Learn the importance of Human values.
3. Developing the overall personality.

Course Contents:

UNIT 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.

UNIT 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.

UNIT 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.

UNIT IV:

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.

UNIT V:

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation.

UNIT VI:

Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

Suggested reading:

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

AUD-905	CONSTITUTION OF INDIA	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To 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. To address the role of socialism in India after the commencement of the Bolshevi Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Contents Outcomes:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Course Contents:

UNIT I:
History of Making of the Indian Constitution: History, Drafting Committee, (Composition and Working)

UNIT II:
Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT III:
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.

UNIT IV:
Organs of Governance:
• Parliament
• Composition
• Qualifications and Disqualifications
• Powers and Functions
• Executive
• President
• Governor
• Council of Ministers
• Judiciary, Appointment and Transfer of Judges, Qualifications
• Powers and Functions

UNIT V:
Local Administration:
• District's Administration head: Role and Importance,
• Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.
• Pachayati raj: Introduction, PRI: Zila Pachayat.
• Elected officials and their roles, CEO Zila Pachayat: Position and role.
• Block level: Organizational Hierarchy (Different departments),
• Village level: Role of Elected and Appointed officials,
• Importance of grass root democracy

UNIT VI:
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.

AUD-906	PEDAGOGY STUDIES	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

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 Contents Outcomes:

At the end of the Course Contents students will be able to

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Course Contents:

UNIT 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.

UNIT II:

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

UNIT 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?

UNIT IV:

• 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.

UNITV:

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

UNIT VI:

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.

AUD-907	STRESS MANAGEMENT BY YOGA	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

1. To achieve overall health of body and mind.
2. To overcome stress.

Course Contents Outcomes:

At the end of the Course Contents students will be able to

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve efficiency.

Course Contents

UNIT I:
Definitions of Eight parts of yog. (Ashtanga)

UNIT II:
Yam and Niyam.

UNIT III:
Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT IV:
Do`s and Don't's in life.
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT V:
Asan and Pranayam
i) Various yog poses and their benefits for mind and body

UNIT VI:
Asan and Pranayam
Regularization of breathing techniques and its effects-Types of pranayam

Suggested reading:

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

AUD-908	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L:02, T:0, P:0	Credits: 00

Course Contents Objectives:

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.
4.

Course Contents Outcomes:

At the end of the Course Contents students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students.
4.

Course Contents

UNIT 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)

UNIT II:

• Verses- 52,53,59 (dont's)
• Verses- 71,73,75,78 (do's)

UNIT III:

Approach to day to day work and duties.

• Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,

UNIT IV:

• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
• Chapter 18-Verses 45, 46, 48.

UNIT V:

Statements of basic knowledge.

• Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
• Chapter 12 -Verses 13, 14, 15, 16,17, 18

UNIT VI:

• Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
• Chapter 4-Verses 18, 38,39
• Chapter18 – Verses 37,38,63

Suggested reading:

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