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Item No. 4.62

# **UNIVERSITY OF MUMBAI**



## **Revised Syllabus for the M.E. Civil Engineering (Water Resources Engineering)**

(As per Choice Based Credit and Grading System  
with effect from the academic year 2016-2017)

## **From Co-ordinator's Desk:-**

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for Master of Engineering from the academic year 2016-2017.

**Dr. S. K. Ukarande**  
**Co-ordinator,**  
**Faculty of Technology,**  
**Member - Academic Council**  
**University of Mumbai, Mumbai**

## Preamble

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education reflects the fact that in achieving recognition, the institution or program of study is committed open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I am happy to state here that, Program Educational Objectives were finalized in a meeting where syllabus committee members were also present. The Program Educational Objectives finalized for undergraduate program in civil Engineering are as follows:

1. To prepare Learner's with a sound foundation in the mathematical, scientific engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To prepare Learner's for successful career in Indian Multinational Organisations to excel in Postgraduate studies
4. To encourage motivate Learner's for self-learning
5. To inculcate professional ethical attitude, good leadership qualities commitment to social responsibilities in the Learner's

In addition to above each institute is free to add few (2 to 3) more Program Educational Objectives of their own. In addition to Program Educational Objectives, course objectives expected course outcomes from learner's point of view are also included in the curriculum for each course of undergraduate program to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

**Dr. S. K. Ukarande**

**Chairman, Board of studies in Civil Engineering**

**University of Mumbai, Mumbai**

**University of Mumbai**  
**Program Structure for Master of Engineering**  
**M.E. Civil Engineering**  
**(Water Resources Engineering Subjects)**  
**(With Effect from -2016-2017)**

**Semester I**

Subject code	Subject Name	Teaching Scheme			Credit Assigned				
		Th.	Prac	Tut	Th	Prac	Tut	Total	
WRC 101	Advanced Fluid Mechanics	03	-	01	03	-	01	04	
WRC 102	Applied Hydrology	03	-	01	03	-	01	04	
WRC 103	Ground Water Engineering	03	-	01	03	-	01	04	
WRDLO 101X	Department Level Optional Course -I	04	--	--	04	--	--	04	
ILO 101X	Institute Level Optional Course-I	03	--	--	03	-	-	03	
WRL101	Laboratory - I		02	-	--	01		01	
WRL102	Laboratory -II		02	-	--	01		01	
<b>Total</b>		<b>16</b>	<b>04</b>	<b>03</b>	<b>16</b>	<b>02</b>	<b>03</b>	<b>21</b>	
Subject code	Subject Name	<b>Examination Scheme</b>							
		<b>Theory</b>							
		<b>Internal Assessment</b>			<b>End Sem Exam</b>	<b>Exam Duration hrs.</b>	<b>Tw</b>	<b>Pr/ Oral</b>	<b>Total</b>
		<b>Test I</b>	<b>Test II</b>	<b>Avg</b>					
WRC 101	Advanced Fluid Mechanics	20	20	20	80	3		100	
WRC 102	Applied Hydrology	20	20	20	80	3		100	
WRC 103	Ground Water Engineering	20	20	20	80	3		100	
WRDLO 101X	Department Level Optional Course -I	20	20	20	80	3		100	
ILO 101X	Institute Level Optional Course-I	20	20	20	80	3		100	
WRL101	Laboratory -I	--	--	--	--	--	25	25	50
WRL102	Laboratory -II	--	--	--	--	--	25	25	50
<b>Total</b>		<b>100</b>	<b>100</b>	<b>100</b>	<b>400</b>		<b>50</b>	<b>50</b>	<b>600</b>

## Semester II

Subject code	Subject Name	Teaching Scheme			Credit Assigned				
		Th	Prac	Tut	Th	Prac	Tut	Total	
WRC 201	Water Resources Economics Planning Management	03	-	01	03	-	01	04	
WRC 202	Design of Hydraulic Structures	03	-	01	03	-	01	04	
WRC 203	System Engineering and its Application	03	-	01	03	-	01	04	
WRDLO201X	Department Level Optional Course -II	04	--	--	04	--	--	04	
ILO 201X	Institute Level Optional Course-II	03	--	--	03	-	-	03	
WRL 201	Laboratory –III		02	-	--	01		01	
WRL 202	Laboratory -IV		02	-	--	01		01	
<b>Total</b>		<b>16</b>	<b>04</b>	<b>03</b>	<b>17</b>	<b>02</b>	<b>03</b>	<b>21</b>	
Subject code	Subject Name	<b>Examination Scheme</b>							
		<b>Theory</b>							
		<b>Internal Assessment</b>			<b>End Sem Exam</b>	<b>Exam Duration hrs.</b>	<b>Tw</b>	<b>Pr/ Oral</b>	<b>Total</b>
		<b>Test I</b>	<b>Test II</b>	<b>Avg</b>					
WRC 201	Water Resources Economics planning and Management	20	20	20	80	3		100	
WRC 202	Design of Hydraulic Structures	20	20	20	80	3		100	
WRC 203	System Engineering and its Application	20	20	20	80	3		100	
WRDLO 201X	Department Level Optional Course -II	20	20	20	80			100	
ILO 201X	Institute Level Optional Course-II	20	20	20	80	3		100	
WRL 201	Laboratory –III	--	--	--	--	--	25	25	50
WRL 202	Laboratory-IV	--	--	--	--	--	25	25	50
<b>Total</b>		<b>100</b>	<b>100</b>	<b>100</b>	<b>400</b>		<b>50</b>	<b>50</b>	<b>600</b>

### Semester III

Subject code	Subject Name	Teaching Scheme Contact hours			Credit Assigned				
		Th.	Prac	Tut	Th	Prac	Tut	Total	
WRC 301	Seminar I	--	06	--	--	03	--	03	
WRD 302	Dissertation I	--	24	--	--	12	--	12	
<b>Total</b>	--	--	30	--	--	15	--	15	
<b>Examination Scheme</b>									
<b>Theory</b>									
Subject code	Subject Name	Internal Assessment			End Sem. Exam	Exam Duration hrs.	Tw	Pr/Oral	Total
		Test I	Test II	Avg.					
WRC 301	Seminar I	--	--	--	--	--	50	50	100
WRD 302	Dissertation I	--	--	--	--	--	100	-	100
<b>Total</b>		--	--	--	--	--	<b>150</b>	<b>50</b>	<b>200</b>

### Semester IV

Subject code	Subject Name	Teaching Schemes (Contact Hours)			Th	Pr	Tut	Total	
		Th	Pr	Tut					
WRD 401	Dissertation II	--	30	--	--	15	--	15	
<b>Total</b>	--	--	30	--	--	15	--	15	
<b>Examination Scheme</b>									
<b>Theory</b>									
Subject Code	Subject name	Internal Assessment			End Sem. Exam	Exam Duration hrs.	Tw	Pr/Oral	Total
		Test I	Test II	Avg.					
WRD 401	Dissertation II	--	--	--	--	--	100	100	200
<b>Total</b>		--	---	--	--	---	<b>100</b>	<b>100</b>	<b>200</b>

**Note:**

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher
- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

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<b>Subject Code</b>	<b>Department Level Optional Course-I</b>	<b>Subject Code</b>	<b>Department Level Optional Course-II</b>
WRDLO1011	Applied Statistics	WRDLO2021	Advance Hydraulic Analysis and Design
WRDLO1012	Watershed Development & Management	WRDLO2022	Integrated River Basin Management
WRDLO1013	Environmental Impact assessment	WRDLO2023	Soft Computing Techniques in Hydrology and Water Resources Engineering
WRDLO1014	Soil Science & Agro Technology	WRDLO2024	Advances in Irrigation Engineering
WRDLO1015	Water Power Engineering		

<b>Subject Code</b>	<b>Institute Level Optional Course-I</b>	<b>Subject Code</b>	<b>Institute Level Optional Course-II</b>
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management



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**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRC 101</b>	<b>ADVANCED FLUID MECHANICS</b>	<b>04</b>

**Objectives:**

1. Study of basic fluid concepts and their applications
2. Study of types of flow and their physics in details
3. Understand the analysis of fluid flow problems

**Outcomes:** Learner will be able to...

1. Understand the basics in details
2. Understand flow patterns, physics and its applications
3. Analyse the problems related to fluid motions

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Ideal fluid motion</b> Review of Fluid mechanics, Kinematics of fluid flow, stream functions and potential functions, Laplace equation and its solution by graphical and relaxation methods, flow nets, dynamics of fluid flow, Euler's equation, application of ideal fluid motion, Source and Sink, Free vortex flow, Source and Uniform flow, Superimposed flow patterns, Source-Sink pair, Source and Sink pair in a uniform flow, Doublet, Flow past a Rankine oval body, Magnus effect, KuttaJoukowski transformation.	8
2	<b>Laminar, Transition and Turbulent flow</b> <b>Laminar Flow:</b> Concept and characteristics of laminar flow, Navier-Stokes equations, creeping motion, approximate and exact solutions. <b>Transition flow:</b> Concept of stability, stability theories, factors affecting transition, Rouse Index <b>Turbulent flow:</b> Classification and characteristics of turbulent flows, statistical approach, Reynolds equations, Reynolds Average N-S (RANS) Equation, Statistical theories of turbulence, turbulence models, Coherent Structures and Turbulent bursting.	10
3	<b>Boundary Flows:</b> Boundary layer concepts, Boundary layer parameters,	8

	Prandtl's boundary layer equations, Blassius solution for laminar boundary layer flows, von-Karman Momentum integral equation and its applications, Laminar boundary layer, Turbulent boundary layer flows, Laminar sub layer, Boundary layer separation and controls.	
4	<b>Unsteady open channel flow</b> Wave celerity, classification of water waves according to relative depth, orbital motions, superposition, wave trains and wave energy, transformation of waves, dissipation of wave energy, positive and negative surges in rectangular channel, Momentum and Continuity Equations (Saint Venant Equation), two dimensional unsteady flows.	8
5	<b>Spatially varied flow</b> Basic principles and assumptions, dynamic equation and analysis of flow profiles, Numerical integration method, Isoclinal method, spatially varied steady and unsteady surface flows. <b>Introduction:</b> Hydrodynamic and Pollutant transfer in open channel	05

#### Recommended Books:

1. Applied Hydrodynamics: H.R. Vallentine, ELBS Publication.
2. Fluid Mechanics: Grade & Mirajgaonkar.
3. Fluid Mechanics: Victor L Streeter & E.B. Wylie, Mc-GrawHill Viscous Fluid Flow: Frank M White, Mc-Graw Hill.
4. Fluid Mechanics and Hydraulics: Dr. S.K. Ukrande, Ane's Books Pvt. Ltd. (Revised Edition, 2012), ISBN 97893 8116 2538.
5. Fluid Mechanics. Kumar, D.S. S.K. Kataria & Sons Publishers, New Delhi, 1998.
6. Fluid Mechanics and Hydraulic Machines: R. K. Bansal, Laxmi Publications (P) Ltd., New, Delhi, 2000.
7. Turbulent Flow: Garde, R.J. New Age International (P) Ltd. Publishers, New Delhi, 2005.
8. Fluid Dynamics: Daiy and Harleman, Addition Wesley, New York, 1973.
9. Fluid Mechanics: R.A. Granger Dover Publications, New York, 1995.
10. RangaRaju K.G., Flow through Open Channels, TATA MC Graw-Graw-Hill publishing Company Limited, 1997.
11. Chow V T, Open Channel Hydraulics, McGraw-Hill Book Company, International editions, New Delhi, 1973.

## SEMESTER I

Subject Code	Subject Name	Credits
<b>WRC 102</b>	<b>APPLIED HYDROLOGY</b>	<b>04</b>

### Objectives:

1. Understand the concepts of hydrology and its processes
2. Understand the terms and concept related to hydrological processes
3. To study and analyse hydrographs and other methods

### Outcomes: Learner will be able to...

1. to know the physics of the hydrological processes
2. to analyse and study the rain-fall, run-off processes
3. to design the flood analysis.

## Detailed Syllabus

Sr. No	Content	Contact Hours
1	<b>Introduction:</b> Introduction to hydrology, hydrological cycle.	02
2	<b>Precipitation:</b> Definition, types and forms of precipitation, precipitation gauges, analysis of data, supplementing missing data, consistency of record, hyetograph, mass curve analysis, depth areas duration analysis. Rainfall frequency analysis.	04
3	<b>Evapotranspiration:</b> Introduction to Evaporation, transpiration, evapotranspiration, Factors affecting, measurement, network design, estimation of evaporation and evapotranspiration, evaporation retardation.	06
4	<b>Infiltration:</b> Capacity, rates and indices, factors affecting, measurement of infiltration, estimation of infiltration capacity from hydrograph analysis.	04
5	<b>Hydrometry:</b> Measurement of discharge, selection of site for stage and discharge measuring station non-recording and recording gauges, accuracy and frequency of observed data, discharge measurement by area velocity method and slope area method.	06
6	<b>Runoff:</b> Runoff, components of runoff, factors affecting runoff, storage effects of runoff from snowmelt, estimation of average monthly and annual runoff, determination of rainfall - runoff relationships by various methods.	06

7	<b>Hydrograph:</b> Introduction to hydrograph, Master recession curve, base flow and its separation , unit hydrograph theory and its application for isolated and complex storms , synthetic unit hydrograph, S- curve, unit hydrograph of varied durations, instantaneous unit hydrograph, conceptual hydrograph.	06
8	<b>Design flood:</b> Rational and empirical relationships, flood frequency analysis, recurrence interval design.	03
9	<b>Introduction to Flood routing:</b> Reservoirs and channels routing.	02

#### Recommended Books:

1. Chow Ven-Te, Maidment, David R. and Mays Larry W., —Applied Hydrology || McGraw hill Publications, 1995.
2. Singh V. P., —Elementary Hydrology || , prentice hall of India, 1994.
3. Rangunath H.M., —Hydrology || , Wiley Eastern Ltd, 1996.
4. Subramanya K. —Engineering hydrology || Mc-Graw Hill, 3<sup>rd</sup> edition, 2009.
5. Jayarami Reddy P., —Stochastic Hydrology || Laxmi Publications

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRC 103</b>	<b>GROUND WATER ENGINEERING</b>	<b>04</b>

**Objectives:**

1. to understand the physics of ground water
2. to study well hydraulics and analysis and modelling of ground water
3. 3.to understand basics of the salt water intrusion in coastal areas

**Outcomes:** Learner will be able to...

1. to know the types of wells and physics of the same
2. to analyse the ground water flow using various modeling approaches
3. get to know the salt water intrusion and how to prevent the same.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Introduction:</b> Ground water occurrence and its role in Hydrological cycle, geological formations such as aquifers; types of aquifers, ground water movement, Darcy's law, permeability and its measurement, tracing of ground water movement, fundamental equations for steady and unsteady ground water flow, flow nets.	09
2	<b>Well hydraulics:</b> Steady and unsteady flow in confined, semi-confined and unconfined aquifers, radial flow, superposition, interference among the wells. Different methods of well construction; construction of well casings and screens, natural and artificial gravel packed wells. Safe yields, estimation, pumping and recuperation tests. Infiltration galleries, ground-water replenishment, recharge of ground water, different ground water recharge methods.	12
3	<b>Groundwater modelling:</b> Physical models, analog models, mathematical modelling, unsaturated flow models. Introduction to numerical models of groundwater flow, finite differential equations, finite difference solution applicable in ground water modelling.	12
4	<b>Salt water intrusion:</b> Concept; interface and its location, control of intrusion, pollutant transport, Plume Transport, source identification, tracer methods, and artificial recharge, remedial measures to prevent salt-water intrusion.	06

### Recommended Books:

1. Todd David Keith, —Groundwater Hydrology  
|| , John W iley publishers
2. Jacob and Bear, —Hydraulics of Groundwater  
|| , M cG raw H ill, 1997.
3. Mutreja K.N., —Applied Hydrology  
New Delhi, 1990.  
-Hill Publishing company Ltd.,
4. Raghunath, —Groundwater & Well Hydraulics  
1992Singh V. P., —Elementary Hydrology  
|| , W iley Ea  
|| , Prentice H all, IN D IA . (19
5. Walton W.C, —Groundwater Modelling Utilities  
-Riley 1992 publications, Boca

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRDLO 1011</b>	<b>APPLIED STATISTICS (Departmental Level Optional Course -I)</b>	<b>04</b>

**Objectives:**

1. 1 to study the basic concepts of statics related to water resources problems.
2. to study the random process analysis and time series concepts
3. to understand the Laplace transform and its application

**Outcomes:** Learner will be able to...

1. analyse the data base and understand the pattern
2. to understand and apply various methods for the analysis
3. to solve water resources related problems using standard methods

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Basic Concepts of Probability Theory:</b> Probability, random variables, moments, moment generating functions, standard distributions, two dimensional random variables, central limit theorem.	06
2	<b>Estimation Theory:</b> Principle of least squares – regression and correlation (multiple and partial), estimation of parameters – maximum likelihood estimates – method of moments.	08
3	<b>Testing of Hypothesis:</b> Sampling distributions tests based on normal. Chi-square and F- distributions, analysis of variance – one way and two way classifications.	08
4	<b>Random Process:</b> Classification – stationary random process, Markov process, Markov chains, Poisson process, birth and death process, simple queuing applications	08
5	<b>Time Series:</b> Characteristics and representation, moving averages, exponential smoothing, auto regressive process, other related models, study of time series plots and scatter plots.	08
6	<b>Laplace transform:</b> Laplace transforms of elementary functions, shifting theorem, change of scale property, Inverse Laplace transforms, Laplace transforms of derivatives, Laplace transforms of integrals.	10



### Recommended Books:

1. Anderson O. D. and Perryman M. R., —Time Series Analysis —Holland  
Amsterdam, 1981.
2. Anderson, O. D., —Time Series Analysis, Theory and Practice I —Holland  
Amsterdam, 1982.
3. Bhat U.N., —Elements of Applied Stochastic Processes in Probabilities  
and Mathematical Statistics, Second Edition, 1984.
4. Freund, John E. and Miller Irwin, —Probability and Statistics for Engineers || , Prentice  
Hall, 1980.
5. John, B., Kennedy and Adam, M. Neville, —Basic Statistical Methods || Harper and  
Publishers, New York, 1986.
6. Spiegel, —Laplace Transform || (Schaum Series).
7. Srinivasan, S. K., and Mehta, K.M., —Probability and Random Processes || , Tata  
McGraw  
Hill, 1981.

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRDLO 1012</b>	<b>WATERSHED DEVELOPMENT AND MANAGEMENT(Department Level Optional Course -I)</b>	<b>04</b>

**Objectives:**

1. to study concept of watershed development and its management
1. to study the soil conservation practices
2. to understand the water shed management and develop the system.

**Outcomes:** Learner will be able to...

1. understand the watershed and its related issues
2. to understand the practices available for soil conservation and chose a better one
3. to design and develop the various watershed models

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Introduction to watershed:</b> Concept, significance of geology, soil and morphological characteristics, land capability classification, delineation, codification, factors influencing, watershed development. Fundamental concepts of geomorphology, geomorphic agents and processes, weathering and soil processes.	08
2	<b>Soil Conservation Practice:</b> Types of Erosion- causes, factors, effects and control, water erosion: engineering measures for erosion control in agricultural and non-agricultural lands, estimation of soil loss, water harvesting techniques, design of small water harvesting structures, types of storage structures, yield from a catchment.	16
3	<b>Watershed Management:</b> Strategies, identification of problems, watershed development, plan entry point activities, concept of priority watersheds, agro forestry, grassland management, wasteland management, watershed approach in government programmes developing collaborative know how, people's participation, evaluation of watershed management.	16
4	<b>Watershed Assessment Models-</b> Regulation and restoration, a brief description and significance of watershed models: SWAT, TMDL, AGNPS, BASINS, and CREAMS – Case Studies.	12

### Recommended Books:

1. Paul, Debarry A., —Watersheds || , W iley and Sons, 2004.
2. Devanport E. Thomas, —Watershed Project Management Guide || , Lew is Publishers, London, 2003.
3. Das, Ghanashyam., —Hydrology and Soil Conservation engineering || , Prentice Hall India Private Limited, New Delhi, 2000.
4. Glenn O. Schwab, —Soil and Water Conservation Engineering || , John Wile 1981.
5. Singh, Gurmail, —A Manual on Soil and Water Conservation || , ICA R Publi Delhi, 1982.
6. Suresh, R., —Soil and Water Conservation Engineering || , Standard Pub Delhi, 1982.
7. Thornbury, W.D., —Principles of Geomorphology || , W iley, 1968.

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRDLO 1013</b>	<b>ENVIRONMENTAL IMPACT ASSESSMENT (Department Level Optional Course -I)</b>	<b>04</b>

**Objectives:**

1. To study the concepts of environmental impact assessment
2. to study the water and air quality management system
3. to study the methods of vegetation and wild life impact analysis

**Outcomes:** Learner will be able to...

1. analyse and understand the environmental impact assessment methods
2. make analysis of air and water quality to design the systems
3. understand the cover of vegetation available and analyse the wild life impact.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Concept of environmental impact analysis:</b> Legislations, laws and acts relevant to environmental protection in India – factors for consideration in assessing environmental impacts- measurement of environmental impacts, short term and long term effects. Socioeconomic impact analysis, types of socioeconomic impacts, outline of the basic steps in performing socioeconomic impact assessment.	14
2	<b>Air quality impact analysis:</b> Air pollutants-sources, atmospheric interaction- environmental impact assessment methodology, noise impact analysis- typical considerations, environmental impacts and effects of noise on people, control of noise pollution.	12
3	<b>Water quality impact analysis:</b> Water quality criteria and standards, environmental .- water quality impacts by projects like highways, power plants, mining, agriculture and irrigation, forest management. energy impact analysis- energy impact considerations, organization and methodology.	14
4	<b>Vegetation and wildlife impact analysis:</b> Environment assessment, methodologies, summarization of environmental, impact checklist method, matrix method, and network method.	10

**Recommended Books:**

1. John G. Rau and David C. Wooten. —Environmental Impact Analysis || Handbook.
2. Canter, Environmental Impact Assessment

SEMESTER I		
Subject Code	Subject Name	Credits
WRDLO 1014	SOIL SCIENCE & AGRO-TECHNOLOGY (Department Level Optional Course -I)	04

**Objectives:**

1. to study the soil, its classification and characteristics
2. to study weeds and how to control
3. to study the crop psychology, dry farming and relate aspects,

**Outcomes:** Learner will be able to...

1. understand the quality of soil through various analysis
2. understand and make use of the knowledge of the soil, weeds and control factors
3. understand various farming methods, climate study and crop patterns

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Classification of soils:</b> Types of soils and characteristics of soils with special significance with reference to agricultural use.	06
2	<b>Properties of Soils:</b> Physical, chemical and biological properties of soils and their utility in crop production, Types of fertilizers and their reactions, preparation of soil maps; crop production potential. Principles of crop production, inputs to crop productions.	08
3	<b>Weeds and methods of weed control:</b> Preventive, cultural, chemical, biological and mechanical control of weeds, soil fertilizer doses as per optimum requirement.	08

4	<b>Crop Physiology:</b> Introduction and principle of crop physiology, Growth and development, seed physiology, vegetative propagation, micro propagation, physiology associated with grafting and rootstocks. Plant and crop stand photosynthesis, Effects of photoperiod, temperature, light intensity and light quality on plant growth and development. Stress physiology related to environmental factors, introduction to growth analysis and simple forecasting systems.	12
5	<b>Dry Land Farming:</b> Introduction to Dry land, dry land agricultural, dry land crops, drought, dry farming, characteristics of dry land agricultural.	08
6	<b>Agro climatology of crop planning:</b> Principles of agro climatology weather elements, climatic elements-and their diurnal, seasonal, and annual variations and its variability. climatology with graphs, maps and atlas showing distribution of pressure, wind, temperature, rainfall, evaporation, radiation and dew, with special reference to climatology of India, water requirement of crops.	10

#### Recommended Books:

1. Foth H.D. and Turk L.M., —Fundamentals of soil science || Wiley publication.
2. Miller R.W. and Donahue R.L. —An introduction to soil and plant growth || 4<sup>th</sup> edition, Englewood Cliffs N.J. Prentice Hall
3. Misra R.D. and Ahmed M., —Manual on Irrigation Agronomy || Oxford & IBH P

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRDLO 1015</b>	<b>WATER POWER ENGINEERING</b> <b>(Department Level Optional Course -I)</b>	<b>04</b>

**Objectives:**

1. to study the water power available in India and demand of water
1. to study stream flow demand and to study hydro power plants
2. to study dams, turbines and other components of hydro water power

**Outcomes:** Learner will be able to...

1. to understand the basics and components of water power
2. to understand and analyse the water conveyance systems
3. to analyse and understand the structures related to storage of water such as dams.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Introduction:</b> Development of water power in India, estimation of hydropower potential, comparison of hydro, thermal and nuclear power.	04
2	<b>Analysis of Stream flow Demand:</b> Flow duration curve, firm power, secondary power, load and load duration curves, load factor, etc.	06
3	<b>Types of Hydropower Plants:</b> Classification of hydropower plants, run-of-river plants, valley dam plants, high head diversion plants, diversion canal plants, pumped storage plants, tidal power plants.	06
4	<b>Water Conveyance System:</b> Power canals, Alignment, Design of power canals, Flumes, Covered conduits and tunnels, Drainage and ventilation in tunnels. Penstocks: - Alignment, types of penstocks, economic diameter of penstocks, Anchor blocks.	08
5	<b>Dams:</b> Selection of site, preliminary investigations, final investigations, types of dams: rigid dams, gravity dams, arch and buttress dams, basic principles of design and details of construction.	08
6	<b>Embankment Dams/ Spillways:</b> Earthen dams, rock fill dams, design considerations. Types, spillway gates, design of stilling basins.	08
7	<b>Turbines and Power house details:</b> Types and utility, layout and parts of	08

	the generation system. forebay, intakes, balancing reservoir, escape , surge shafts/ inclined shafts. General layout of power house and arrangement of hydropower units. underground power stations : general information	
8	<b>Transmission System:</b> General introduction, basic principles of design and construction. Financial implications of hydropower plants.	04

**Recommended Books:**

1. Mosonyi, E., —Water Power Development || Vol. I & II
2. Brown, G. Etal., —Hydro Electric Engineering Practice || Vol. I, II & III
3. Dandekar M.M., —Water Power Engineering || Vikas Pub. House Pvt.L td



Course Code	Course Name	Credits
ILO1011	PRODUCT LIFE CYCLE MANAGEMENT	03

**Objectives:**

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

**Outcomes:** Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.

Module	Detailed Contents	Hrs
01	<p><b>Introduction to Product Lifecycle Management (PLM):</b>Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance &amp; Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications</p> <p><b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM</p>	10
02	<p><b>Product Design:</b> Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and</p>	09

	Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
03	<b>Product Data Management (PDM):</b> Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	<b>Virtual Product Development Tools:</b> For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies	05
05	<b>Integration of Environmental Aspects in Product Design:</b> Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	<b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

### Assessment:

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### Recommended Books:

1. John Stark, —Product Lifecycle Management: Paradigm for 21st Century Product Realisation -Verlag 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, —Product Design for the environment-A life cycle approach 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, —Product Life Cycle Management ||, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, —Product Lifecycle Management: Driving the next generation of lean thinking 0070636265 raw Hill, 2006, ISBN :

Course Code	Course Name	Credits
ILO1012	RELIABILITY ENGINEERING	03

**Objectives:**

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

**Outcomes:** Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	<p><b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</p> <p><b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</p> <p><b>Measures of Dispersion:</b> Mean Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</p>	08
02	<p><b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</p> <p><b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.</p> <p><b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</p>	08
03	<p><b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</p>	05

04	<p><b>Reliability Improvement:</b> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.</p> <p>System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.</p>	08
05	<p><b>Maintainability and Availability:</b> System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement.</p> <p>Availability – qualitative aspects.</p>	05
06	<p><b>Failure Mode, Effects and Criticality Analysis:</b> Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis</p>	05

### Assessment:

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

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1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

#### **Recommended Books:**

1. L.S. Srinath, —Reliability Engineering -Wiley India Pvt. Ltd., 1985.



Course Code	Course Name	Credits
ILO1013	MANAGEMENT INFORMATION SYSTEM	03

**Objectives:**

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

**Outcomes:** Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C.	7

	Mobile commerce.	
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

**Assessment:**

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**End Semester Theory Examination:**

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4. Only Four question need to be solved.

**Recommended Books:**

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008



Course Code	course name	Credits
ILO1014	DESIGN OF EXPERIMENTS	03

**Objectives:**

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

**Outcomes:** Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyse, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	<p><b>Introduction</b></p> <p>1.1 Strategy of Experimentation</p> <p>1.2 Typical Applications of Experimental Design</p> <p>1.3 Guidelines for Designing Experiments</p> <p>1.4 Response Surface Methodology</p>	06
02	<p><b>Fitting Regression Models</b></p> <p>2.1 Linear Regression Models</p> <p>2.2 Estimation of the Parameters in Linear Regression Models</p> <p>2.3 Hypothesis Testing in Multiple Regression</p> <p>2.4 Confidence Intervals in Multiple Regression</p> <p>2.5 Prediction of new response observation</p> <p>2.6 Regression model diagnostics</p>	08

	2.7 Testing for lack of fit	
<b>03</b>	<b>Two-Level Factorial Designs and Analysis</b> 3.1 The $2^2$ Design 3.2 The $2^3$ Design 3.3 The General $2^k$ Design 3.4 A Single Replicate of the $2^k$ Design 3.5 The Addition of Center Points to the $2^k$ Design, 3.6 Blocking in the $2^k$ Factorial Design 3.7 Split-Plot Designs	07
<b>04</b>	<b>Two-Level Fractional Factorial Designs and Analysis</b> 4.1 The One-Half Fraction of the $2^k$ Design 4.2 The One-Quarter Fraction of the $2^k$ Design 4.3 The General $2^{k-p}$ Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
<b>05</b>	<b>Conducting Tests</b> 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
<b>06</b>	<b>Taguchi Approach</b>	04

6.1 Crossed Array Designs and Signal-to-Noise Ratios	
6.2 Analysis Methods	
6.3 Robust design examples	

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**End Semester Theory Examination:**

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4. Only Four question need to be solved.

**Recommended Books:**

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2<sup>nd</sup> Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, —Taguchi Technique for Quality Engineering, || M cG raw H ill
7. Madhav S Phadke, —Quality Engineering using Robust Design, || Prentice H a.l.l.

Course Code	Course Name	Credits
ILO1015	OPERATIONS RESEARCH	03

**Objectives:**

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

**Outcomes:** Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	<p><b>Introduction to Operations Research:</b> Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, <b>Duality</b>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p>	14

	<p><b>Assignment Problem:</b> Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p> <p><b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	
02	<p><b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
03	<p><b>Simulation:</b> Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation</p>	05
04	<p><b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.</p>	05
05	<p><b>Game Theory.</b> Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.</p>	05
06	<p><b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,</p>	05

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**End Semester Theory Examination:**

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4. Only Four question need to be solved.

**Recommended Books:**

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO1016	CYBER SECURITY AND LAWS	03

**Objectives:**

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

**Outcomes:** Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	<b>Introduction to Cybercrime:</b> Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	<b>Cyber offenses &amp; Cybercrime:</b> How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	<b>Tools and Methods Used in Cyberline</b> Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms,	6

	Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
04	<b>The Concept of Cyberspace</b> E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	<b>Information Security Standard compliances</b> SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

**Assessment:**

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**End Semester Theory Examination:**

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**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.



### Recommended Books:

1. Nina Godbole, SunitBelapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO1017	DISASTER MANAGEMENT AND MITIGATION MEASURES	03

**Objectives:**

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

**Outcomes: Learner will be able to...**

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	<b>Introduction</b> 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	<b>Natural Disaster and Manmade disasters:</b> 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	<b>Disaster Management, Policy and Administration</b> 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster	06

	<p>management.</p> <p>3.2 Policy and administration:</p> <p>Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.</p>	
04	<p><b>Institutional Framework for Disaster Management in India:</b></p> <p>4.1 Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.</p> <p>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</p>	06
05	<p><b>Financing Relief Measures:</b></p> <p>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.</p> <p>5.2 International relief aid agencies and their role in extreme events.</p>	09
06	<p><b>Preventive and Mitigation Measures:</b></p> <p>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general</p> <p>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</p> <p>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.</p> <p>6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.</p>	06

## **Assessment:**

### **Internal:**

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### **End Semester Theory Examination:**

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4. Only Four question need to be solved.

### **Recommended Books:**

1. Disaster Management by Harsh K.Gupta, Universities Press Publications.
2. Disaster Management: An Appraisal of Institutional Mechanisms in India by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. Introduction to International Disaster Management by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. Disaster Management Handbook by Jack Pinkowski, CRC Press Taylor and Francis group.
5. Disaster management & rehabilitation by RajdeepDasgupta, Mittal Publications, New Delhi.
6. Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites).

Course Code	Course Name	Credits
ILOS 1018	ENERGY AUDIT AND MANAGEMENT	03

**Objectives:**

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

**Outcomes: Learner will be able to...**

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyse the data collected during performance evaluation and recommend energy saving measures.

Module	Detailed Contents	Hrs
01	<b>Energy Scenario:</b> Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	<b>Energy Audit Principles:</b> Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08

03	<p><b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.</p> <p><b>Energy efficiency measures in lighting system, Lighting control:</b> Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofiting, soft starters, variable speed drives.</p>	10
04	<p><b>Energy Management and Energy Conservation in Thermal Systems:</b> Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.</p> <p>General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</p>	10
05	<p><b>Energy Performance Assessment:</b> On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</p>	04
06	<p><b>Energy conservation in Buildings:</b> Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</p>	03

**Assessment:**

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

MUQuestionPapers.com

4. Only Four question need to be solved.

**Recommended Books:**

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. [www.energymanagertraining.com](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://www.bee-india.nic.in)



**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRL101</b>	<b>LABORATORY- I</b>	<b>01</b>

Sr. No	Content
1	To determine the infiltration rate of a particular plot of land using double ring infiltrometer, and construct infiltration capacity curves.
2	To study the variation of meteorological parameters, such as air temperature, relative humidity, wind speed and wind direction using thermo hygrometer and anemometer.
3	To study the variation of hydrological parameters, water level and water temperature/ conductivity in a bore well using water level recorder.
4	To study free vortex and forced vortex phenomenon.
5	Performance characteristics of turbines.

**SEMESTER I**

Subject Code	Subject Name	Credits
<b>WRL102</b>	<b>LABORATORY-II</b>	<b>01</b>

Sr. No	Content
1	Measurement of velocity distribution in open channel using Pitot tube and current meter.
2	Establishment of subcritical, critical and supercritical flows in open channel, development of specific energy diagram.
3	Characteristics of hydraulic jump in open channel.
4	Measurement and computation of gradually varied flow profiles in open channel and its critical assessment.
5	To study infiltration capacity of different type of soils using Infiltrometer and its significance.
6	To study fresh-soil water interface using Hele-Shaw apparatus and critical analysis
7	Study of seepage analysis of earthen dam using Electrical analogy.
8	Design of practical profile of Gravity dam/ Design of Spillway profile (any one)

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRC 201</b>	<b>WATER RESOURCES ECONOMICS PLANNING AND MANAGEMENT</b>	<b>04</b>

**Objectives:**

1. To get acquainted with Planning and decision making process
2. To gain the knowledge of economics and planning with respect to global scenario.
3. To know Methods and analysis of multi objective planning
4. To understand the process of polymerization and know the different applications of polymers to construction field.
5. To understand the concept of International development on water transfer

**Outcomes:** Learner will be able to...

1. Understand need and importance and necessity of planning, decision making process
2. Asses, and apply discounting techniques, Price theory, Resource allocation, project optimality conditions.
3. Able to preparation feasibility report

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Planning and decision making process:</b> Importance and necessity of planning, decision making process and various types and feasibility.	03
2	<b>Systems Approach To Water Resource Planning:</b> Water as economic commodity, Principles of economics.	06
3	<b>Economics of Planning:</b> Global scenario of water resources planning, Discounting techniques, Price theory, Resource allocation, project optimality conditions. Cost benefits studies, Role of benefit cost parameters in project selection. Economic feasibility tests. Decision making under uncertainty and risk. Cost benefit studies of single & multipurpose projects. Economic planning, capacity expansion.	12

4	<b>Multi objective planning:</b> Methods and analysis of multi objective planning, Stakeholders' participation, Preparation of feasibility report, interstate water disputes and case study.	08
5	<b>International development on water transfer:</b> Principles and challenges of IWRM. Importance and necessity, international water laws, trity etc.	10

**Recommended Books:**

1. Kuiper, —Water Resources Project Economics || Butterworth, London. 1
2. M. C. Chaturvedi, —Water Resources System Planning and Management || (1987), Tata McGraw Hill Co. New Delhi.
3. Helweg, O.J. —Water Resources Planning and Management || John Wiley USA.1985.

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRC 202</b>	<b>DESIGN OF HYDRAULIC STRUCTURES</b>	<b>04</b>

**Objectives:**

1. To understand planning and investigation of reservoir
2. To know the design criteria for safe design of embankment dam,
3. To understand design concept of arch and buttress dam.
4. To understand structural health monitoring procedures

**Outcomes:** Learner will be able to...

1. Select the site for dam with preliminary and final investigations, fix storage capacity, analyze reservoir losses, and estimate sedimentation in reservoirs.
2. Analyze forces acting on gravity dam its failure and carry out stability analysis of gravity dams.
3. Understand forces on an arch and buttress dams and its design.
4. Understand details of construction and maintenance of earth fill and rock fill dams including stability analysis criteria.
5. Understand design principles of spillways, energy dissipation works and flood control works.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Planning and investigations of reservoir and dam sites:</b> Choice and site selection of dams and reservoirs, Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams, galleries, dam safety and hazard mitigation.	09
2	<b>Homogeneous and zoned embankment dams:</b> factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body	09

	and dam foundation, classification of rock fill dams and their design consideration, causes and failure of earthen dam.	
3	<b>Arch and buttress Dams:</b> Types of arch dams and buttress dams, design and analysis of arch dams and buttress dams, and their suitability.	06
4	<b>Spillways:</b> Capacity of spillways, components and profile of different types spillways, Non-conventional type of spillways, selection and design of energy dissipaters	05
5	<b>Diversion headworks:</b> Components of diversion head works and their functions, weirs barrages, Blighs Creep theory, Lanes weighed theory. Design of weirs and barrages on permeable foundations.	06
6	<b>Canal structures:</b> Canal outlets, types of cross-drainages works, review of codes of practice, design of canal drops, operation and maintenance of canals.	04

### Recommended Books:

1. USBR, —Design of gravity dams || , A Water Res  
Colorado, 1976.
2. USBR, —Design of small dams r||resources technical publication, Oxford and  
IBH publishing co., New Delhi, 1974.
3. Creager W P, Justin J. D and Hinds J., —Engineering for dams || N em Chand  
Roorkee, 1995.
4. Irrigation Engineering and Hydraulic structures (Abridged Edition). Dr S.K.  
Ukarande, Ane's Student Edition., 2015.
5. Khatsuria, R M, —Hydraulics of spillways and energy dissipators || , CRC Press, 20
6. Novak P, —Hydraulic Structures || , Taylor and Francis G
7. Grishin, M. M. Ed., —Hydraulic Structures ||, Mir Publishers, Moscow, 1982.

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRC 203</b>	<b>SYSTEM ENGINEERING AND ITS APPLICATION</b>	<b>04</b>

**Objectives:**

1. To study the Economics and Concept of Optimization
2. To understand the Conventional Optimization techniques
3. To study various optimization techniques

**Outcomes:** Learner will be able to...

1. Analysis engineering economics related water resources development
2. Able to understand Conventional Optimization techniques
3. Able to apply optimization techniques in water resources problems.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<p><b>Economics and Concept of Optimization</b> Principles of Engineering Economics -Equivalence of Kind, Equivalence of Time, Sunk Cost, Incremental Cost, Intangible Values, Predictive Uncertainty, Planning, Alternatives, Objectives of water resources development, Economic Analysis and Discounting Techniques, Project Optimality Conditions</p>	09
2	<p><b>Conventional Optimization techniques</b> <b>Linear Programming:</b> Formulation of problem, graphical solutions, simplex method. Solution by simplex method – Variations from standard form, the dual problem, Dual simplex method. Sensitivity analysis, Non-linear programming, one dimensional minimization methods – Newton – Raphson method, interval halving method, Fibonacci method, Big M method, Two-phase method, duality. <b>Transportation problems:</b> BFS-Optimality test, maximization problems. Assignment Problems -minimization, maximization. <b>Dynamic Programming(DP):</b> Introduction, solution of DP problems, characteristics of a DP problem, principle of optimality</p>	12
3	<p><b>Application of optimization techniques</b></p>	09

	Applications of various optimization techniques to water resources engineering problems, applications Non-linear programming, water quality subsystem, optimum operation model for reservoir systems by incremental dynamic programming, sequence of multipurpose projects.	
4	Case Studies- Conjunctive use of ground water and surface water, hydropower optimization, crop yield optimization, multi-basin and multi-reservoir systems. A Linear Programming Optimization of Water Resource Management with Virtual Water through Global Trade. Nonlinear Reservoir Optimization Model with Stochastic Inflows. Water resources management by stochastic optimization. Model for optimal allocation of water resources in saltwater intrusion area	09

### Recommended Books:

1. S. Vedula & P. M. Mujumdar, Water Resources Systems, Tata McGraw-Hill Publishing Company Ltd.
2. A. Ravindran, Don T. Philips & James J. Solberg, Operations Research – principles And Practice. John Wiley & Sons.
3. Daniel P. Loucks, Jerry R. Stedinger & D.A. Haith, Water Resources systems Planning and Management. UNESCO Publishing.
4. Hall, W.A. & Dracup, J.A., Water Resources Systems Engineering.
5. Mays L.W., and Tung YK, Hydro systems Engineering and Management. McGraw Hill Inc., New York, 19925.
6. Singiresu S Rao, Engineering Optimization Theory and Practice. New Age International (P) Ltd., Publishers, New Delhi.
7. Wagner, H. M., 'Principles of Operations Research', Prentice - Hall, 1975.
8. Arthur Mass et al, Design of Water Resources Systems, Macmillan, 1970.
9. Alvin.S. Goodman, Principles of Water Resources Planning, Prentice Hall, Englewood Cliffs, New Jersey, 1984.

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRDLO 2021</b>	<b>ADVANCED HYDROLOGIC ANALYSIS AND DESIGN(Department Level Optional Course -II)</b>	<b>04</b>

**Objectives:**

1. To study Hydrologic and Hydraulic Models
2. To study Hydrologic Simulation and Stream Flow Synthesis
3. To understand concept of Forecasting Models

**Outcomes:** Learner will be able to...

1. Apply Hydrologic and Hydraulic Models to water resources problems.
2. Able to perform hydrological simulation
3. Able to do forecasting and prediction.

**Detailed Syllabus**

Sr. No	Content	Contact Hours
1	<b>Hydrologic and Hydraulic Models:</b> Hydrologic investigations, systems approach, and concept of a model. Classification of hydrological models, Chow-Kulandaiswamy model. Time-area methods, unit hydrograph, Instantaneous Unit Hydrograph. Synthetic Unit Hydrographs. Clark model, Nash model, Tank model.	12
2	<b>Hydrologic Simulation and Stream Flow Synthesis:</b> Classification of hydrologic simulation models. Single-event rainfall-runoff models. Continuous simulation models, groundwater flow simulation models. Stream flow synthesis, risk analysis – design storms and its synthesis. Design flows, urban storm drainage, design, airport drainage design, detention storage design.	12
3	<b>Random Processes:</b> Classification, stationary random process, components of time series, trend analysis, regression, multiple linear regression, diagnostic tools.	10
4	<b>Forecasting Models:</b> Box Jenkins' models, correlation, Auto correlation, Partial auto correlation – Yule Walker equations – AR (p) – MA (q) – ARMA (p,q) – ARIMA (p,d,q) models, model formulation, validation, and application.	18



**Recommended Books:**

1. Singh, V. P.,—Hydrologic Systems", Prentice-Hall Englewood Cliffs, NJ 1989.
2. Jayarami Reddy P., —Stochastic Hydrology || Laxmi Publications, N
3. Viessman W Jr. —Introduction to Hydrology (5ed) || Pearson Education, Inc
4. Haan C.T., —Statistical Methods in Hydrology || Iowa State Press 2002.

## SEMESTER II

Subject Code	Subject Name	Credits
WRDLO 2022	<b>INTEGRATED RIVER BASIN MANAGEMENT (Department Level Optional Course -II)</b>	<b>04</b>

### Objectives:

1. To understand the concept of integration in the river basin.
2. To study River basin planning and management
3. To study climate change and water resources sustainability

### Outcomes: Learner will be able to...

1. Analysis integrated water resource planning management including water supply and demand management.
2. Able to evaluate and of environmental goods environmental and social cost-benefit analysis
3. Able to take strategic decision making at river basin scheme.

### Detailed Syllabus

Sr. No	Content	Contact Hours
1	<b>Introduction:</b> Global and national scenario in general. Naturally functioning river basin river system. Concept of integration in the river basin setting. Conservation, management and development of water. Economic and social benefits, restoring freshwater ecosystem.	12
2	<b>River basin planning and management:</b> water quantity and quality and its protection; Land use; socio-economic condition; Integrated water resource planning management including water supply and demand management; urban and rural water development; decision support for river basin management; International river basin management including conflict and resolution and sustainable development. Maintenance of echo system, conventional approaches.	14
3	<b>Climate change and water resources sustainability:</b> Reasons, details of climate change, and sustainable development introduction to cost-benefit analysis economic evaluation of environmental goods environmental and social cost-benefit analysis.	14

4	<b>Long term vision:</b> Stake holders and initiates, integration of policies, decision and cost across, sectoral interest includes industry, agricultural, urban development, navigation, fisheries, fisheries management and conservations, strategic decision making at river basin scheme.	12
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**Recommended Books:**

1. Kemper, Karin; Blomquist, William; Dinar, —Integrated River Basin Management through Decentralization || Ariel (Eds.) 2007.
2. Saha S.K., —River management theory and practice || Chichester: John Wiley & Sons, 2003.
3. Falconer R. A. —River basin management || Cardiff University, 1992.  
R. BLAIN, Wessex Institute of Technology, United Kingdom.

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRDLO 2023</b>	<b>SOFT COMPUTING TECHNIQUES IN HYDROLOGY AND WATER RESOURCES ENGG (Department Level Optional Course -II)</b>	<b>04</b>

**Objectives:**

1. To understand various soft computing techniques, importance.
2. To study basic concepts-Neural network and genetic algorithm.
3. To understand Concept of hybrid system and its significance in general to water resources problems.

**Outcomes:** Learner will be able to...

1. Able to apply ANN and Fuzzy techniques for water resources problems
2. To apply genetic algorithm for optimization problem.
3. Able to perform prediction and simulation with soft computing techniques.

Sr. No	Content	Contact Hours
1.	<b>Introduction to Soft computing techniques-</b> soft computing techniques, importance, types of soft computing techniques, advantages and limitations.	16
2	<b>Introduction to Fuzzy logic:</b> Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations- Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Defuzzification methods-Fuzzy logic controller (Block Diagram).	12
3	<b>Artificial Neural Networks:</b> Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self organizing maps.	12
4	<b>Fundamentals of genetic algorithms and Genetic Programming:</b> Basic concepts- working principle – encoding different methods – fitness function, reproduction-different methods. Genetic modeling in inheritance- Crossover mutation-convergence of genetic algorithm. Basic difference between genetic algorithm and genetic programming.	12
5	<b>Introduction to Hybrid systems:</b> Concept of hybrid system and its significance in general to water resources problems,Neural network, fuzzy	10

logic and genetic algorithm hybrids – Neurofuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back propagation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.	
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### Recommended Books:

1. Rajasekharan, S. and Vijayalakshmi, G.A.Pai, —Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications ||, Prentice Hall India.
2. Sivanandam, S.N and Deepa, S.N. —Principles of Soft Computing ||, Wiley India
3. Ross Timothy J, —Fuzzy logic with Engineering Applications ||, McGraw New York.
4. Haykins S. —Neural Networks a Comprehensive foundation ||, Pearson Education
5. Goldberg, D.E. —Genetic Algorithms in Search Optimization and Machine Learning .||, Pearson Education Recent Literature

**SEMESTER II**

Subject Code	Subject Name	Credits
<b>WRDLO 2024</b>	<b>ADVANCES IN IRRIGATION ENGINEERING (Department Level Optional Course -II)</b>	<b>04</b>

**Objectives:**

1. To collect the data for irrigation system.
2. To calculate the storage capacity of reservoirs.
3. To find out and fix the control levels of reservoirs.
4. To understand concept of river training works.

**Outcomes:** Learner will be able to...

1. Able to preparation of irrigation schedules.
2. To able to design storage capacity of reservoir
3. Able to design river training works.

Sr. No	Content	Contact Hours
1	<b>Irrigation Techniques:</b> Surface and Subsurface Irrigation, well Irrigation, Lift Irrigation, Sprinkler Irrigation and Drip Irrigation. Hydraulic design of Lift, Sprinkler & Drip Irrigation. Assessment of irrigation water, Audit of irrigation water. Preparation of irrigation schedules based on crop water requirement. Different types of irrigation water distribution.	12
2	<b>Reservoir operations:</b> Introduction to reservoir operations, types -Storage capacity of reservoir – Storage zones – Determining reservoir capacity for a given yield – Determining yield from a reservoir of a given capacity – Reservoir Losses – Reservoir sedimentation – Silt control. Operation and maintenance of canal system, canal automation. River training, diversion and protection works. Reservoir operations.	18
3	<b>Rivers training:</b> types of rivers – its characteristics – Indian rivers and their classification – Straight reaches – Bends – Meanders –Cutoff – Control and training of rivers – Objectives of river training – Classification of river training – Levees –Guide banks – Groynes – Artificial cutoffs – Pitched islands.	12
4	<b>Principles of irrigation water management:</b> Irrigation Efficiencies – Need for optimization – Management and productivity – Participatory approach – On farm development – Command area development.	10

### Recommended Books:

1. Zimmerman, —Irrigation Engineering || Wiley Toppan publication.
2. Sharma, S.K. —Principles and practice of Irrigation Engineering || . Chand and  
Ltd. New Delhi.
3. Michael, A. Irrigation.,—Theory and practice || Vikas publishing house.
4. —Canal Automation || IPublication No. 238, New Delhi.
5. Asawa G.L., —Irrigation Engineering || , New Age Internatic
6. Asawa G.L., —Irrigation and Water Resources Engineering || , New Age  
Publishers, 2007.

Course Code	Course Name	Credits
ILO2021	PROJECT MANAGEMENT	03

**Objectives:**

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

**Outcomes:** Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	<p><b>Project Management Foundation:</b></p> <p>Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical &amp; atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).</p>	5
02	<p><b>Initiating Projects:</b></p> <p>How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development &amp; growth (forming, storming, norming &amp; performing), team dynamics.</p>	6
03	<p><b>Project Planning and Scheduling:</b></p> <p>Work Breakdown structure (WBS) and linear responsibility chart, Interface</p>	8



	Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	
04	<p><b>Planning Projects:</b></p> <p>Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.</p> <p>Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks</p>	6
05	<p><b>5.1 Executing Projects:</b></p> <p>Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.</p> <p>Team management, communication and project meetings.</p> <p><b>5.2 Monitoring and Controlling Projects:</b></p> <p>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p><b>5.3 Project Contracting</b></p> <p>Project procurement management, contracting and outsourcing,</p>	8
06	<p><b>6.1 Project Leadership and Ethics:</b></p> <p>Introduction to project leadership, ethics in projects.</p> <p>Multicultural and virtual projects.</p> <p><b>6.2 Closing the Project:</b></p> <p>Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	6

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

#### **Recommended Books:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup> Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO2022	FINANCE MANAGEMENT	03

**Objectives:**

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

**Outcomes:** Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p><b>Concepts of Returns and Risks:</b> Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p><b>Time Value of Money:</b> Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06

03	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09
04	<p><b>Capital Budgeting:</b> Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p><b>Working Capital Management:</b> Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	10
05	<p><b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p><b>Capital Structure:</b> Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</p>	05
06	<p><b>Dividend Policy:</b> Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach</p>	03

## **Assessment:**

### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### **Recommended Books:**

1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	ENTERPRENEURSHIP DEVELOPMENT AND MANAGEMENT	03

**Objectives:**

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

**Outcomes:** Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	<p><b>Overview Of Entrepreneurship:</b> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership</p> <p>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship</p>	04
02	<p><b>Business Plans And Importance Of Capital To Entrepreneurship:</b> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur</p> <p><b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations</p>	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs,	05

	case studies, exercises	
04	<b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	<b>Effective Management of Business:</b> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	<b>Achieving Success In The Small Business:</b> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

**Assessment:**

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### **Recommended Books:**

1. PoornimaCharantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. RashmiBansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. LaghuUdyogSamachar
11. [www.msme.gov.in](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://www.msmetraining.gov.in)



Course Code	Course Name	Credits
ILO2024	HUMAN RESOURCE MANAGEMENT	03

**Objectives:**

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

**Outcomes:** Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<p><b>Introduction to HR</b></p> <ul style="list-style-type: none"> <li>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</li> <li>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</li> </ul>	5
02	<p><b>Organizational Behavior (OB)</b></p> <ul style="list-style-type: none"> <li>• Introduction to OB Origin, Nature and Scope of Organizational</li> </ul>	7

	<p>Behavior, Relevance to Organizational Effectiveness and Contemporary issues</p> <ul style="list-style-type: none"> <li>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> <li>• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.</li> <li>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</li> <li>• Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.</li> <li>• Case study</li> </ul>	
03	<p><b>Organizational Structure &amp; Design</b></p> <ul style="list-style-type: none"> <li>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	6
04	<p><b>Human resource Planning</b></p> <ul style="list-style-type: none"> <li>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</li> <li>• Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counseling, Career Planning.</li> <li>• Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>	5
05	<p><b>Emerging Trends in HR</b></p> <ul style="list-style-type: none"> <li>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>• Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.</li> </ul>	6
06	<p><b>HR &amp; MIS</b></p> <p>Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries</p>	10

	<p><b>Strategic HRM</b></p> <p>Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p><b>Labor Laws &amp; Industrial Relations</b></p> <p>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	
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**Assessment:**

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**Recommended Books:**

1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup> edition, 2015
5. P. SubbaRao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	PROFESSIONAL ETHICS AND CORPORAT SOCIAL RESPONSIBILITY (CSR)	03

**Objectives:**

1. To understand professional ethics in business
2. To recognized corporate social responsibility

**Outcomes:** Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	<b>Professional Ethics and Business:</b> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	<b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy <b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	<b>Introduction to Corporate Social Responsibility:</b> Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection.	05

	Trajectory of Corporate Social Responsibility in India	
05	<b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	<b>Corporate Social Responsibility in Globalizing India:</b> Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

**Assessment:**

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**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**Recommended Books:**

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	RESEARCH METHODOLOGY	03

**Objectives:**

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

**Outcomes:** Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	<p><b>Introduction and Basic Research Concepts</b></p> <p>1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</p> <p>1.2 Need of Research in Business and Social Sciences</p> <p>1.3 Objectives of Research</p> <p>1.4 Issues and Problems in Research</p> <p>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</p>	09
02	<p><b>Types of Research</b></p> <p>2.1. Basic Research</p> <p>2.2. Applied Research</p> <p>2.3. Descriptive Research</p> <p>2.4. Analytical Research</p>	07

	<p>2.5. Empirical Research</p> <p>2.6 Qualitative and Quantitative Approaches</p>	
03	<p><b>Research Design and Sample Design</b></p> <p>3.1 Research Design – Meaning, Types and Significance</p> <p>3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors</p>	07
04	<p><b>Research Methodology</b></p> <p>4.1 Meaning of Research Methodology</p> <p>4.2. Stages in Scientific Research Process:</p> <p>a. Identification and Selection of Research Problem</p> <p>b. Formulation of Research Problem</p> <p>c. Review of Literature</p> <p>d. Formulation of Hypothesis</p> <p>e. Formulation of research Design</p> <p>f. Sample Design</p> <p>g. Data Collection</p> <p>h. Data Analysis</p> <p>i. Hypothesis testing and Interpretation of Data</p> <p>j. Preparation of Research Report</p>	08
05	<p><b>Formulating Research Problem</b></p> <p>5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</p>	04
06	<p><b>Outcome of Research</b></p> <p>6.1 Preparation of the report on conclusion reached</p> <p>6.2 Validity Testing &amp; Ethical Issues</p> <p>6.3 Suggestions and Recommendation</p>	04

### **Assessment:**

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#### **End Semester Theory Examination:**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

#### **Recommended Books:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup> ed), Singapore, Pearson Education



Course Code	Course Name	Credits
ILO2027	IPR AND PATENTING	03

**Objectives:**

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

**Outcomes:** Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	<p><b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.</p> <p><b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</p>	05
02	<p><b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement</p> <p><b>Indian Scenario of IPR:</b> Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.</p>	07
03	<p><b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce,</p>	05

	human genome, biodiversity and traditional knowledge etc.	
04	<b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	<b>Patent Rules:</b> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	<b>Procedure for Filing a Patent (National and International):</b> Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement  <b>Patent databases:</b> Important websites, Searching international databases	07

**Assessment:**

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Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### Recommended Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Lewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
<b>ILO2028</b>	<b>DIGITAL BUSINESS MANAGEMENT</b>	<b>03</b>

**Objectives:**

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

**Outcomes:** The learner will be able to .....

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	<p><b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy,</p> <p><b>Drivers of digital business-</b> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p>	09
2	<p><b>Overview of E-Commerce</b></p> <p><b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p>	06

	EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	
3	<b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Tope Apps, Information and referral system  <b>Application Development:</b> Building Digital business Applications and Infrastructure	06
4	<b>Managing E-Business-</b> Managing Knowledge, Management skills for e-business, Managing Risks in e –business  Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	<b>E-Business Strategy-</b> E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition  (Process of Digital Transformation)	04
6	<b>Materializing e-business: From Idea to Realization-</b> Business plan preparation  <b>Case Studies and presentations</b>	08

**Assessment:**

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### **Recommended Books:**

1. A textbook on E-commerce, ErArunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO2029	ENVIRONMENTAL MANAGEMENT	03

**Objectives:**

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

**Outcomes:** Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities.  Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency.  Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

## **Assessment:**

### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

### **Recommended Books:**

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing. 2015



**SEMESTER II**

Subject Code	Subject Name	Credits
WRL 201	<b>LABORATORY- III</b>	<b>04</b>

Sr. No	Content
1	Rainfall data collection by natural siphon recording type rain gauge and determination of mass curve & hyetograph from obtained data and its analysis.
2	Determination of $\phi$ index by double ring type infiltrometer and its significance.
3	Measurement of permeability of soil and analysis
4	Determination of rate of evaporation
5	Measurement of Water quality parameters
6	Study and analysis of pumping test well (expected to perform test on well)
7	Design of rain water harvesting system

**SEMESTER II**

Subject Code	Subject Name	Credits
WRL 202	<b>LABORATORY-IV</b>	<b>04</b>

Sr. No	Content
1	Assignment based on dam break problem or model study on a hydraulic structure or open channel and detailed analysis.
2	Design of any type of irrigation scheme
3	Uses of software's for water resource planning
4	Visit to a hydraulic structure & preparation of visit report.
5	Assignments based on stability analysis of gravity/earth/rockfill dams.
6	Assignments based on linear programming or dynamics programming in irrigation engineering/hydrology
7	Development of computer program to solve pipe network problem,
8	Study of total station; Study measurement of angle by repetition and setting the horizontal angle to value. Basic level measurement-distance

### Semester III

Subject Code	Subject Name	Credits
<b>WRC 301</b>	<b>Seminar</b>	<b>03</b>

#### Guidelines for Seminar

- Seminar should be based on thrust areas with practical applications in water resource engineering and its allied subjects including hydraulics, irrigation engineering and environmental engineering.
  - The objective behind seminar is to equip the student for carrying out literature survey, summarize the findings of the literature and formulate the problem or arrive upon the statement of the problem. Along similar lines, the student can work for their dissertation in the subsequent stages.
  - The student in consultation with the Supervisor shall settle or finalize / identify the topic of the seminar in the context of the specialization or allied theme. The students shall carry out literature survey pertaining to the topic, various sub-topics/ approaches/ methods falling within the purview of the topic. The student shall use multiple literatures and understand the topic, analyze the literature and summarize the findings. The report shall be compiled in a standard format. The student shall have to present the the seminar/presentation in front of the board of examiners (refer note below).
  - It is expected by the student to publish a technical papers may in form of review or state of art in consultation with the supervisor. Paper may be published at reputed national conference or international conference.
  - The supervisor may ask the student to author a technical paper based on the seminar report and present it in a seminar or conference of national repute. Publication of paper in an International Conference shall be preferred. The paper could be a review paper.
  - The assessment of the seminar shall be assessed in respect of the following points:
    - Quality of Literature survey and Novelty in the topic
    - Relevance to the specialization
    - Understanding of the topic
    - Quality of Written and Oral Presentation
- Efforts made by the students to author a technical paper (preferably of review nature) and its subsequent publication either in the journal or in the conference proceedings and presentation in the conference.

#### IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research

Organizations such as IIT, NIT, BARC OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.
3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3<sup>rd</sup> Semester.

## Semester IV

Subject Code	Subject Name	Credits
WRD 302 / WRD401	Dissertation (I and II)	12

### Guidelines for Dissertation

- Student should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for Dissertation and finalize/ settle it in consultation with Guide/ Supervisor.
- Pursuant to this, the student shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.
- Student should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The students shall compile the report in standard format.
- Student should publish at least one paper based on the work in reputed International / National Conference in which papers are blindly reviewed (desirably in Refereed Journal). More weightage shall be given for the journal publication.
- The work to be pursued as a part of the dissertation shall be divided broadly in two parts, namely- Dissertation Stage I and Dissertation Stage II.
- The topic of the Dissertation should be such that it is a value addition for the existing knowledge in the field and has some worthwhile research input.

### Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)/ Data Collection, etc.
- Dissertation I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department/Institute of respective Programme.

### Guidelines for Assessment of Dissertation II

After completion of about 80% of the work (which shall be decided by the Guide/ Supervisor), proposed to be a part of the Dissertation, the student shall deliver a Pre-submission seminar based on the work pursued by him/ her during the second stage. It will be assessed by the panel of internal examiners appointed by the Head of the Department/ Institute of the respective programme, as the case may be.

The student shall take into account the suggestions made by the examiners/s during pre-submission seminar in view of the work pursued by the students and shall try to incorporate it in the work, if the suggestions are worthwhile, consistent with the situation and provided they are such that those can be accommodated/ included in the work being pursued by the candidate at that point of time.

After the pre-submission seminar, the student shall compile the report in a standard format and written in the systematic manner and chapter wise.

The student shall adhere to the following scheme of chapterization while compiling the final report in general. The Guide/ Supervisor shall ensure the student has written the Dissertation Report in appropriate language (grammatically correct).

1. Introduction: The student shall give the introduction to the theme of the subject chosen as a Dissertation, give further current state of art related to the theme (i.e., brief review of literature), broad problem definition and scope of the work. The student shall also state at the end of this chapter the scheme of chapterization included in his/ her Dissertation.
2. Theoretical Aspects/ Review of Literature: The student is expected to highlight the various theoretical aspects pertaining to the topic chosen, literature (updated) available related to the various aspects of the topic chosen citing the research work carried out by the earlier researchers and summarize the findings of the literature. The student may state the precise the problem definition.
3. Formulation/ Methodology/ Experimental Work: In this chapter, the student is expected to explain the methodology for pursuing his/ her work. In case of analytical work, student may give the Formulation along with validation for assessment of accuracy of the numerical procedure being used/ proposed by him/ her. In respect of experimental work, the student may outline the experimental set up/ procedure. In case of the work in which either approach is involved, the student may appropriately provide the methodology to cover either approach. This chapter may be supported by the Data Collection if the work involves the Collection of the Data and its subsequent processing.
4. Analysis/ Results and Discussion: The student is expected to present the results emerging from the analytical/ theoretical/ experimental study/ studies being pursued by the students. The results shall be discussed properly. The results may be compared with the results published by the earlier researchers if the work being pursued by the student warrants the same. The student may indicate the broad conclusions/ inferences at the end.
5. Summary and Conclusions: Based on the results discussed in the previous chapter, the student shall give in the systematic manner the conclusions/ inferences emerged from the study and summarize it properly. The student shall indicate the scope of the future work

which can be extended by any other student/ researcher in the future. The student may point out the limitation/s left out in the work pursued by him/ her while carrying out the work contained in the Dissertation.

6. Recommended Books::: The student shall at the end give the list of the Recommended Books:: in the appropriate manner. This part should not be treated as a Chapter. For referencing style, student may refer any standard journal of national and international repute.
7. Publication/s: The student shall give the list of the technical/ research papers published/ accepted for publication in the referred journal/ conference proceedings. This part should not be treated as a Chapter.

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)
  - Quality of work attempted
  - Presentation of the results along with the validation of results or part thereof.
  - Quality of Written Report and Oral Presentation
  - Publication of the technical/ research paper by the student in a conference of National/ International repute. Publication of paper in a referred/ peer reviewed journal is highly preferred.
- Dissertation II shall be assessed through a presentation jointly by the Internal Examiner (Guide/ Supervisor) and External Examiner appointed by the University of Mumbai.