Shri Rawatpura Sarkar University, Raipur

Examination Scheme & Syllabus

for

B.Tech. In Civil Engineering

Semester-V

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Session: 2022-23)

Shri Rawatpura Sarkar University, Raipur, Chhattisgarh
Faculty of Engineering

Four Years B.Tech. Programme

Scheme of Teaching and Examination

B.Tech. Fifth Semester Civil Engineering

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

S.No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs)
			L	**T**	**P**		Continuous Evaluation	Sem End Exam	Total	
1	BENCE501T	Structural Analysis-II	3	1	-	4	30	70	100	3
2	BENCE501P	Structural Analysis-II	-	-	2	1	15	35	50	
3	BENCE502T	Structural Engineering Design-I	3	1	-	4	30	70	100	3
4	BENCE503T	Geotechnical Engineering-I	3	1	-	4	30	70	100	3
5	BENCE503P	Geotechnical Engineering-I	-	-	2	1	15	35	50	
6	BENCE504T	Transportation Engineering – II	3	1	-	4	30	70	100	3
7	BENCE505T	Hydrology and Water Resource Engineering	3	1	-	4	30	70	100	3
8	BENCE506P	Practical Training Evaluation	-	-	2	1	15	35	50	-
9	BENCE507P	Soft Skill Development	-	-	2	1	15	35	50	-
	Total Contact Hours Per Week: 28		**Total Credit: 24**				**Grand Total Marks**		**700**	

L: Lecture T: Tutorial P: Practical

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<table>
<tr><td>Course Title</td><td colspan="5">Structure Analysis-II</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE501T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Structure Analysis-I</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
• Learn the methods which are applied to analyze indeterminate structures.
• Gain the expertise in analysis of indeterminate beams and rigid frames.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT-I

Method of Three Moments
Indeterminate beams, Principle of superposition. Analysis by consistent deformation method, Theorem of three moments, shear force and bending moment diagrams, sinking of support.

UNIT-II

Method of Strain Energy
Strain energy of linear elastic systems due to axial load, bending moment and torsion. Minimum strain energy and Castigliano’s second theorem, strain energy application to indeterminate beams and rigid frames. Application of Castigliano’s theorem of minimum strain energy to externally and internally indeterminate pin-jointed plane frames, yielding of supports, stresses due to lack of Fit.

UNIT-III

Method of Moment Distribution
Moment Distribution Method, Application to indeterminate beams and rigid frames without sway and with sway problem.

UNIT-IV

Method of Slope Deflection And Column Analogy
Slope deflection method, Application to indeterminate beams and rigid frames without sway and with sway problem. Basics of Column analogy method and application for fixed beams.

UNIT-V

Influence Lines By Muller Breslau Principle
Qualitative and quantitative influence lines of indeterminate beams by</td></tr>
</table>

	Muller Breslau Principle, its use and its application propped Cantilevers and continuous beams.
Course Outcomes	**After the completion of course:** • Capable of analyzing different kinds of structures such as determinate, indeterminate, rigid jointed or pin-jointed plane frames. • Capable of understanding about the suitable method for a given structure. • Capable of drawing influence line diagram for determinate and indeterminate beams and to find out maximum values of stress function. • Ready to proceed for designing of analyzed structure. • Develop professional skill in analyzing indeterminate pin joint structures.
Text Books	1. SMTS – II Theory of Structures – Punmia B.C., A. K. Jain, A. K. Jain (Laxmi Publications) 2. Fundamentals of Structural Analysis (with Computer Analysis and Applications) – Sujit Kumar Roy and Subrata Chakrabarty (S. Chand) 3. Basic Structural Analysis – C.S. Reddy (Tata McGraw Hill)
Reference Books	1. Intermediate Structural Analysis – Wang. C.K. (Tata McGraw Hill) 2. Fundamentals of Structural Analysis – Harry H. West and Louis F. Gesch windner (Wiley India) 3. Theory of Structures (Vol. I & Vol. II) – G. Pandit, S. Gupta & R. Gupta (Tata McGraw Hill) 4. Structural Analysis – Hibbeler (Pearson Education) 5. Fundamentals of Structural Mechanics and Analysis – M. L. Gambhir (PHI Learning)

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<table>
<tr><td>Course Title</td><td colspan="5">Structural Analysis-II</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE501P</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>-</td><td>-</td><td>2</td><td>1</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Structural Analysis-II</td></tr>
<tr><td>Course Objectives</td><td colspan="5">. This course will enable students to:
Learn the methods which are applied to analyses indeterminate structures.
Gain the expertise in analysis of indeterminate beams and rigid frames.
Develop professional skill in analyzing indeterminate pin jointed structures.</td></tr>
<tr><td>Course Contents</td><td colspan="5">List of Experiments:
To determine the flexural rigidity (EI) for a given beam & To verify the Maxwell’s theorem of reciprocal deflection
To determine the vertical deflections of a variety of curved bars.
To obtain the horizontal deflection and deformed shape of portal frames with different end conditions.
To determine the strain in an externally loaded beam with the help of digital strain indicator.
Analysis of determinate beams on a Standard Structural Analysis Package such as SAP2000.
Analysis of indeterminate beams on a Standard Structural Analysis Package such asSAP2000.
Analysis of determinate pin-jointed frames on a Standard Structural Analysis Package such as SAP2000.
Analysis of indeterminate pin-jointed frames on latest version of a Standard Structural Analysis Package such as SAP2000.
Analysis of determinate rigid frames on latest version of a Standard Structural Analysis Package such as SAP2000.
Analysis of indeterminate rigid frames on latest version of a Standard Structural Analysis Package such as SAP2000.
To draw influence lines for determinate beams on latest version of a Standard Structural Analysis Package such as SAP2000.
To draw influence lines for indeterminate beams on latest version of a Standard Structural Analysis Package such as SAP2000.</td></tr>
</table>

	• Introduction to the latest version of a Standard Finite Element Analysis Package such as ANSYS. • Analysis of a plate with a hole on the latest version of a Standard Finite Element Analysis Package such as ANSYS.
Course Outcome	**After the completion of course:** • Capable of analyzing different kinds of structures such as determinate, indeterminate, rigid jointed or pin-jointed plane frames. • Capable of understanding about the suitable method for a given structure. • Capable of drawing influence line diagram for determinate and indeterminate beams and to find out maximum values of stress function. • Ready to proceed for designing of analyzed structure.
Text Books	1. Reference Manual of Respective Software 2. Verification Manual of Respective Software
Reference Books	1. Intermediate Structural Analysis – Wang. C.K. (Tata McGraw Hill) 2. Fundamentals of Structural Analysis – Harry H. West and Louis F. Geschwindner (Wiley India) 3. Theory of Structures (Vol. I & Vol. II) – G. Pandit, S. Gupta & R. Gupta (Tata McGraw Hill) 4. Structural Analysis – Hibbeler (Pearson Education) 5. Fundamentals of Structural Mechanics and Analysis – M. L. Gambhir (PHI Learning)

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<table>
<tr><td>Course Title</td><td colspan="5">Structural Engineering Design–I</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE502T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Mechanics, Frame Structure</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
Educate the student about the concept of reinforced cement concrete and different method of design of reinforced concrete.
Educate the student about concept of working stress method to analysis and design of beams.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT-I

Basis of Working Stress Method
Properties of Concrete and reinforcing steel, stress-strain curves, permissible stresses, modular ratio, loads on structure, Basis for design by working stress method. Analysis and design of singly reinforced and doubly reinforced sections by working stress method, shear in beams.

UNIT-II

Limit State Method – Rectangular Beams
Introduction to limit state method, characteristic loads, partial safety factor, limit state of flexure – assumptions, stress block parameters, neutral axis, analysis and design of singly and doubly reinforced section, shear in beams, bond and development length, design of lintels.

UNIT-III

Limit State Method – T-Beams And Slabs
Properties of T-section, moment of resistance and design of singly reinforced T-beam. Dead loads, imposed loads, thickness of slabs, modification factors, effective span, reinforcement in slab, design of one-way slab and two-way slabs.

UNIT-IV

Limit State Method – Columns
Axially loaded short columns, minimum eccentricity, longitudinal and transverse reinforcement, and effective length of column, safe load on columns, circular columns, Pu – Mu interaction curves, combined axial load and uni-axial bending, combined axial load and bi-axial bending.</td></tr>
</table>

	UNIT-V **Limit State Method –Staircases And Column Footings** Design of stairs – doglegged stair, open newel stair. General principle of design of reinforced concrete footing, proportioning of footings, edge thickness, depth of footing, design of isolated column footings – square and rectangular footings. **Note:** **1. All designs should be as per latest version of code (IS 456: 2000)** **2. IS 456: 2000 is permitted in the Examination Hall.** **3. Design Aids (SP 16: 1980) are not to be allowed in the examination.**
Course Outcomes	**After the completion of course:** • Understand the importance of reinforced concrete structure. • Understand the procedure of analysis and design of other elements such as slabs, columns, footings and staircases. • Understand the different method of analysis and design of reinforced concrete structures. • Understand the procedure of analysis and design of beams by working stress and limit state method. • Educate the student about analysis and design of footings and staircases by limit state method.
Text Books	1. Limit State Design of Reinforced Concrete B.C. Punmia, A.K. Jain and A.K.Jain (Laxmi Publications) 2. Limit State Theory and Design of Reinforced Concrete (IS: 456-2000)– V.L.Shah and S. R.Karve (Structures Publications, Pune) 3. Reinforced Concrete Design – S. U. Pillai and D. Menon (Tata McGraw Hill)
Reference Books	1. Relevant IS codes IS: 456:2000, IS 875, Part 1,2 2. Reinforced Concrete Structures – Dayaratam P. (Oxford and IBH Publishing Co.) 3. Reinforced Concrete Limit State Design – Jain, A.K. (Nem Chand and Bros. Roorkee) 4. Fundamentals of Reinforced Concrete Design – M. L. Gambhir (PHI Learning) 5. Design of Reinforced Concrete Structures – M. L. Gambhir (PHI Learning) 1. Design Aids for Reinforced Concrete to I.S.-456-1978 SP16,1980 (Bureau of Indian Standards, New Delhi)

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Course Title	**Geotechnical Engineering–I**				
Course Code	**BENCE503T**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**-**	**4**	
Prerequisites	**Learning The Properties of Soil**				
Course Objectives	**This course will enable students to:** • Impart knowledge about various types of soils, index properties of soils and soil classification system. • Impart knowledge about permeability, seepage in soils. • Impart knowledge about stress distribution within the soils, compaction characteristics and consolidation principles. • Impart knowledge about shear strength of soils and their determination based upon various drainage conditions.				
Course Contents	**UNIT-I** **Introduction, Phases of Soil** Formation of soil, Residual and Transported soils, generally used in practice such as Sand Gravel,, Silt, Clay and Black cotton soils, Three and Two Phase system of soils, Various soil weights and Volume relationships. **Index Properties and their Determination** Water content, Specific Gravity, consistency limits, sieve analysis and in situ density, Density Index, Differential and Free Swell determination. **Classification of Soils** Types of Classification and explanation, Field Identification of Expansive soils. **UNIT-II** **Permeability** Darcy law and its Validity, Discharge and seepage velocity, Factors affecting permeability of soils, Lab Tests explanation, Permeability of stratified soil deposits **Seepage** Seepage pressure and Quick condition, Laplace equation and flow nets, Total, Effective and neutral Pressures. **UNIT-III** **Stress Distribution** Stress Distribution in soil mass, Boussinesq analysis, Point load, uniformly distributed loaded circular area, strip load, line load and rectangular area, Point load				

	approximation and New marks influence chart. **UNIT-IV** **Compaction** Compaction definition, standard and modified proctor tests, Factors affecting compaction, Field compaction **Consolidation** Compression of laterally confined soil Spring analogy and types of consolidated soils, Virgin curve, pre consolidation pressure determination and settlements, Terzaghi one dimensional consolidation theory. **UNIT-V** **Shear Strength** Shear Strength definition, Mohr's and Coulomb Theory, Drainage conditions, Direct shear test and Tri axial test, Modified strength envelop, unconfined compression test , Vane shear test and sensitivity of soils**.**
Course Outcomes	**After the completion of course students:** • Have knowledge about phase's system of soils, soil weights and volume relationships, index properties and their determination, classifications of soils. • Have Knowledge regarding permeability and seepage in the soil. • Gain knowledge regarding stress distribution in the soil for various types of loading conditions and also its determination. • Know the concept of compaction, consolidation and its field applications. • Know the concept of shear strength in soils and determination of shear strength of soils by using various methods and also by various drainage conditions.
Text Books	1. Soil Mechanics and Foundations – B.C. Punmia, A. K. Jain, A. K. Jain (Laxmi Publication) 2. Soil Engineering in Theory and Practice (Vol-II) – Alam Singh (Asia Publishing House)
Reference Books	1. Soil Mechanics and Foundation Engineering – S.N. Murthy (Dhanpat Rai Publications) 2. Basic and Applied Soil Mechanics – Gopal Ranjan and Rao A.S.R. (New Age International) 3. Design Aids in Soil Mechanics and Foundation Engineering – S.R. Kaniraj (Tata McGraw Hill) 4. Geotechnical Engineering Principles and Practice – D. P. Coduto (Prentice Hall of India 5. Soil Mechanics and Foundation Engineering – Garg S.K. (Khanna Publishers) 6. Soil Mechanics and Foundation Engineering – Purushothama Raj (Pearson Education) 7. Text Book of Geotechnical Engineering – I. H. Khan (PHI Learning)

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<table>
<tr><td>Course Title</td><td colspan="5">Geotechnical Engineering–I</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE503P</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>-</td><td>-</td><td>2</td><td>1</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Geotech Engineering-I</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
Know about the types of soil according their classification, classification system, field identification, study of effective stress, capillary seepage force, etc.
How to measure the compaction and permeability of soil by lab experiments theoretically uses of Darcy law. Two dimensions flow and develop flow net and characteristics.
Know about stresses due to applied load a soil mass, consolidation and their factor one dimensional consolidation as per Terzaghi's theory
Find shear strength in soil with the help of Mohr circle. How shear strength can be determine in laboratory, soil exploration.</td></tr>
<tr><td>Course Contents</td><td colspan="5">List of Experiments: (At least Ten experiments are to be performed by each student)
To determine the mass density of soil by core cutter method.
To determine the specific gravity of soil sample by pycnometer method.
To determine the water content of soil (%) by oven dry method.
To determine in situ dry density of soil by sand replacement method.
To determine the particle size distribution of a soil by dry mechanical analysis (sieve analysis).
To determine the liquid limit of a soil sample.
To determine the plastic limit of a soil sample.
To determine the shrinkage limit of soil sample.
Study of permeability by falling head and constant head methods.
To determine the grain size distribution by wet mechanical analysis (Hydrometer apparatus).
To determine the liquid limit of soil sample by static cone penetrometer method.
Study of cyclic plate load test.
Study of various field control test method.</td></tr>
</table>

	• Study of Skempton's pore pressure parameters. • Determination of density for contaminated soil.
Course Outcome	**After the completion of course:** • Know about soil and development of soil mechanics and soil formation and characteristic of soil. • Field identification, soil classification system. • Study the lab experiments and simulations of experiment result with the theoretical characteristic of soil. • Study of different theory Newmart Charts, Westergaard and Boussinesq equation. • Able to find at experiment, shear strength of soil and different method of soil exploration.
Text Books	1. Soil Mechanics and Foundation Engineering – B.C. Punmia (Laxmi Publication)
Reference Books	1. Soil Engineering in Theory and Practice (Vol-II) – Alam Singh (Asia Publishing House, New Delhi)

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<table>
<tr><td>Course Title</td><td colspan="5">Transportation Engineering–II</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE504T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Transportation Engineering-I, Tunnel Engineering and Harbour Engineering.</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
Educate the students on the various means of transportation i.e., Railway Engineering, Bridge Engineering, Tunnel Engineering and Harbour Engineering.
Expose the students to the concepts of Geometric design of Railway Engineering.
Expose the students to the concepts of Bridge Engineering.
Educate the students to the concepts of Tunnel and Harbour Engineering.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT-I

Railway Engineering
Railway track cross-section, coning of wheels, rail cross-section, weight of rail, length of rail, wear of rails, creep of rails, rail joints and welding of rail, sleepers, various types, spacing and density fastenings, ballasts.

UNIT-II

Railway Geometrics
Grading, cant and cant deficiency, transition curves, widening of gauges on curves. Point and crossing, design of turnouts various types of track junctions, signaling and interlocking, signals, and control of movements of trains.

UNIT-III

Bridge Engineering
Bridge site investigation and planning, selection of bridge site, alignment, collection of bridge design data, economic span, and scour depth, depth of foundation afflux, clearance, and freeboard.

UNIT-IV

Tunnel Engineering
Consideration in tunneling shape and size, method soft tunnel, constructions,</td></tr>
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	tunneling in soft soil and rocks, lining of tunnels, ventilation, drainage of tunnels. **UNIT-V** **Harbour Engineering** Harbour layout, harbor works, break water jetties, wharves, piers and berthing facilities, port facilities, docks, transit shed and warehouses.
Course outcome	**After the completion of course:** • A person with broad vision and knowledge of different means of Transportation Engineering. • The students will be able to make safe design for railway track with high speed. • The students will be able to know, what are the selection of site and collection of data for Bridge Design. • The students will be able to understand methods of construction of Tunnel. • Educate the students to the concepts of Harbour Engineering.
Text Books	1. Railway Engineering – S.C. Saxena and S.P. Arora, "A textbook of Railway Engineering", (Dhanpat Rai Publications) 2. Railway Engineering – S.C. Rangwala, "Railway Engineering", (Charotar Publishing House Pvt. Ltd.) 3. Bridge Engineering–S.P.Bindra, "Principles and practice of bridge engineering",(Dhanpat Rai Publications) 4. Tunnel Engineering – S.C. Saxena (Dhanpat Rai Publications) 5. Harbour Engineering – R. Srinivasan (Charotar Publishing House Pvt. Ltd)
Reference Books	1. Tunnel and Harbour – Seetharaman S. (Umesh Publication) 2. Harbour Engineering – R. Srinivasan (Charotar Publishing House Pvt. Ltd.)

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<table>
<tr><td>Course Title</td><td colspan="5">Hydrology and Water Resource Engineering</td></tr>
<tr><td>Course Code</td><td colspan="5">BENCE505T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Runoff And Estimation of Runoff</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
• Understand basic concepts of hydrology and hydrologic cycle
• Understand the concepts of precipitation and its measurement.
• Learn about runoff and estimation of runoff.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT-I

Introduction
Hydrologic Cycle, History of Hydrology, Water-Budget Equation, , World Water Balance, Applications in Engineering, Sources of Data.

Precipitation
Forms of Precipitation, Characteristics of Precipitation in India, Measurement of Precipitation, Rain Gauge Network, Mean Precipitation over an Area, Depth Area-Duration Relationships, Maximum Intensity/Depth-Duration-Frequency Relationship, Probable Maximum Precipitation (PMP), Rainfall Data in India.

UNIT-II

Abstractions from Precipitation - Evaporation Process, Evaporimeters, Analytical Methods of Evaporation Estimation, Reservoir Evaporation and Methods for its Reduction, Evapotranspiration, Interception, Depression Storage, Infiltration, Infiltration Capacity, Measurement of Infiltration, Modelling Infiltration Capacity, Classification of Infiltration Capacities, Infiltration Indices.
Runoff - Runoff Volume, SCS-CN Method of estimating runoff volume, Flow Duration Curve, Flow-Mass Curve, Hydrograph, Factors Affecting Runoff Hydrograph, Components of Hydrograph, Base Flow Separation, Effective Rainfall, Unit Hydrograph Surface Water Resources of India, Environmental Flows.

UNIT-III

Water Withdrawals And Uses – Water for Energy Production, Water for Agriculture, Water for Hydroelectric Generation; Flood Control. Analysis of Surface Water Supply, Water Requirement of Crops and Crop Seasons in India, Cropping Pattern, Duty And Delta; Quality of Irrigation Water; Soil-Water Relationships, Root Zone Soil Water, Infiltration, Consumptive use, Irrigation Requirement, Frequency of Irrigation; Methods of Applying Water to The Fields: Surface, Sub-Surface, Sprinkler and Trickle / Drip Irrigation.

Distribution Systems - Canal Systems, Alignment of Canals, Canal Losses, Estimation</td></tr>
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	of Design Discharge. Design of Channels- Rigid Boundary Channels, Alluvial Channels, Kennedy's and Lacey's Theory of Regime Channels. Canal Outlets: Non-Modular, Semi-Modular And Modular Outlets. **UNIT-IV** **Water Logging:** Causes, Effects And Remedial Measures. Lining of Canals, Types of Lining. Drainage of Irrigated Lands: Necessity, Methods. **UNIT-V** **Dams And Spillways** - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site..
Course Outcomes	**After the completion of course:** • Understand the interaction among various processes in the hydrologic cycle. • Calculate the average annual rainfall of any area using the rain gauge data and inter-relations of various parameters as infiltration, evapotranspiration etc. • Understand the various component of hydro graphs and able to estimate the runoff.. • Find the water requirement for different crops and able to proposed appropriate method of applying water. • Understand the distribution system of canal and various components of irrigation system. • Classify dams and spillways, their problems and able to determine forces exerted by fluid on dams.
Text Books	1. K Subramanya, Engineering Hydrology, Mc-Graw Hill. 2. K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill.
Reference Books	1. K Subramanya, Water Resources Engineering through Objective Questions, Tata McGraw Hill. 2. G L Asawa, Irrigation Engineering, Wiley Eastern 3. L W Mays, Water Resources Engineering, Wiley 4. J. D Zimmerman, Irrigation, John Wiley & Sons. 5. C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford