

**Savitribai Phule Pune University  
(Formerly University of Pune)**



**Department of Technology  
Board of Studies, Civil & Environmental (CE) Technology  
Curriculum Structure for M.Tech Program**

| Sr. No.               | Subject Code | Subject Name                                   | Credits   | Teaching Scheme (Theory) | Teaching Scheme (Lab) |
|-----------------------|--------------|--|-----------|--------------------------|-----------------------|
| <b>Semester (I)</b>   |              |  |           |                          |                       |
| 1                     | MMaths       | Mathematics for Technology                     | 3         | √                        |                       |
| 2                     | CEC2         | Advanced Design of Concrete Structures         | 3         | √                        |                       |
| 3                     | CEC3         | Construction Management                        | 3         | √                        |                       |
| 4                     | CEC4         | TQM in Construction                            | 3         | √                        |                       |
| 5                     | CEE*         | Elective-1                                     | 3         | √                        |                       |
| 6                     | CELP1        | Lab Practice - 1                               | 3         |                          | √                     |
| 7                     | CESM1        | Seminar - 1                                    | 1         |                          | √                     |
| <b>Semester (II)</b>  |              |  |           |                          |                       |
| 8                     | CEC5         | Fluid Mechanics                                | 3         | √                        |                       |
| 9                     | CEC6         | Design of Water & Wastewater Treatment Systems | 3         | √                        |                       |
| 10                    | CEC7         | Air Pollution and Control                      | 3         | √                        |                       |
| 11                    | CEC8         | Adv. Town Planning Engineering                 | 3         | √                        |                       |
| 12                    | CEE*         | Elective-2                                     | 3         | √                        |                       |
| 13                    | CELP2        | Lab Practice - 2                               | 3         |                          | √                     |
| 14                    | CESM2        | Seminar - 2                                    | 1         |                          | √                     |
| <b>Semester (III)</b> |              |  |           |                          |                       |
| 15                    | TSD          | Technical Skill Development                    | 3         | √                        |                       |
| 16                    | CEE*         | Elective-3                                     | 3         | √                        |                       |
| 17                    | CEIntProj    | Interim Project                                | 10        |                          | √                     |
| <b>Semester (IV)</b>  |              |  |           |                          |                       |
| 18                    | CEFinProj    | Final Project (Dissertation Submission)        | 16        |                          | √                     |
|                       |              | <b>TOTAL CREDITS</b>                           | <b>70</b> |                          |                       |

| <b>AUDIT COURSES</b> |                     |  |                |                 |
|----------------------|---------------------|--|----------------|-----------------|
| <b>Sr. No.</b>       | <b>Subject Code</b> | <b>Subject Name</b>  | <b>Credits</b> | <b>Semester</b> |
| 1                    | CYSA                | Cyber Security   | 2              | I               |
| 2                    | HRE101              | Human Rights & Duties  | 1              | I               |
| 3                    | HRE102/HRE103       | Human Rights &<br>Vulnerable Groups/Law<br>Policy , Society &<br>Enforcement mechanism | 1              | II              |

Notes:

- 1) Electives can also be Open Electives in spirit of CBCS.
- 2) Maximum 25% Open Electives are allowed.
- 3) Candidates are expected to perform minimum three (3) assignments for every Lab Practice, and submit report as a bona fide document to supervisor/course instructor. The assignment may be in the form of modeling/ simulation/ programming/ experimental investigation/ fieldwork
- 4) The candidates are expected to select three electives from the list provided in Table(s) in this document

LIST OF ELECTIVES FOR BOARD OF CIVIL AND ENVIRONMENTAL TECHNOLOGY

| Sr. No. | Stream | Subject Code | Subject Name  |
|---------|--------|--------------|---|
| 1       | STR    | CEE1         | Theory of Elasticity  |
| 2       | WR     | CEE2         | Optimization Techniques   |
| 3       | CM     | CEE3         | TQM in Construction   |
| 4       | CM     | CEE4         | Green construction  |
| 5       | CM     | CEE5         | Construction Techniques and Equipments                          |
| 6       | CM     | CEE6         | Risk Analysis and Mitigation                                    |
| 7       | ENV    | CEE7         | Air & Water Quality Modeling                                    |
| 8       |        | CEE8         | Transportation System Engineering                               |
| 9       | CM     | CEE9         | MIS in construction Industry                                    |
| 10      | CM     | CEE10        | Human resource Management in construction Industry              |
| 11      | CM     | CEE11        | Construction contracts and materials management                 |
| 12      | CM     | CEE12        | Project Economics and Financial Management                      |
| 13      | CM     | CEE13        | Construction Materials and Techniques                           |
| 14      | CM     | CEE14        | Work study and Incentive Management                             |
| 15      | CM     | CEE15        | Maintenance and rehabilitation of buildings                     |
| 16      | CM     | CEE16        | Solar Energy and Buildings                                      |
| 17      | ENV    | CEE17        | Industrial Wastewater Management                                |
| 18      | ENV    | CEE18        | Sanitary Chemistry & Microbiology                               |
| 19      | ENV    | CEE19        | Energy & Environment  |
| 20      | ENV    | CEE20        | Environmental Sanitation & Sanitation Practices for Rural India |
| 21      | ENV    | CEE21        | Environmental Structure Design                                  |
| 22      | ENV    | CEE22        | Environmental Legislation and Management System                 |
| 23      | ENV    | CEE23        | Environmental Geo technology                                    |

|    |     |       |   |
|----|-----|-------|---|
| 24 | ENV | CEE24 | Solid and Hazardous Waste Management            |
| 25 | ENV | CEE25 | Air Pollution and Control                       |
| 26 | STR | CEE26 | Advanced Structural Analysis By Matrix Approach |
| 27 | STR | CEE27 | Reliability Based Civil Engineering Design      |
| 28 | STR | CEE28 | Dynamics of Structures                          |
| 29 | STR | CEE29 | Plastic Analysis & Design of Steel Frames       |
| 30 | STR | CEE30 | Finite Element Method                           |
| 31 | STR | CEE31 | Soil-Structure Interaction                      |
| 32 | STR | CEE32 | Theory of Plates and Shells                     |
| 33 | STR | CEE33 | Advanced Design of Steel Structures             |
| 34 | STR | CEE34 | Advanced Foundation Design                      |
| 35 | STR | CEE35 | Earthquake Resistant Design of Structures       |
| 36 | STR | CEE36 | Design of Precast Components and Ferrocete      |
| 37 | WR  | CEE37 | Dam Engineering                                 |
| 38 | WR  | CEE38 | Wave Mechanics                                  |
| 39 | WR  | CEE39 | Planning & Management of Water resources        |
| 40 | WR  | CEE40 | Open channel flow                               |
| 41 | WR  | CEE41 | Irrigation and Drainage                         |
| 42 | WR  | CEE42 | Sediment Transport & River Mechanics            |
| 43 | WR  | CEE43 | Ground water modeling                           |
| 44 | WR  | CEE44 | Hydrology                                       |
| 45 | WR  | CEE45 | Remote sensing and GIS in wRE                   |
| 46 |     | CEE46 | Project Monitoring and Control                  |
| 47 |     | CEE47 | Engineering contract Administration             |

|    |  |        |   |
|----|--|--------|---|
| 48 |  | CEE48  | Sustainable Materials   |
| 49 |  | CEE49  | Concrete Technology   |
| 50 |  | CEE50  | Transport infrastructure planning, development and evaluation |
| 51 |  | CEE51  | Sanitary chemistry and microbiology                           |
| 52 |  | CEE52  | TQM and MIS in civil engg.                                    |
| 53 |  | CEE53  | Advanced Hydrology  |
| 54 |  | CEE54  | Public Transport Management                                   |
| 55 |  | CEE55  | Valuation   |
| 56 |  | CEE56  | Pavement Distress   |
| 57 |  | CEE57  | Advanced Statistics   |
| 58 |  | CEE58  | Advanced Waste Water Treatment                                |
| 59 |  | CEE59  | Introduction to Enzymes and Fermentation Technology           |
| 60 |  | CEE60  | Intellectual Property Rights                                  |
| 61 |  | CEDS1  | Advanced Earthquake Resistant Design of Structures            |
| 62 |  | CEDS52 | Adv. TQM in Construction                                      |

**S.P.Pune University**

**Department of Technology**

## **SYLLABUS FOR MTech- Integrated MTech-PhD (Civil and Environmental Technology)**

### **MATHEMATICS FOR TECHNOLOGY (COMPUTATIONAL METHODS)**

#### **Unit 1: Numerical differentiation I:**

Partial differential equation Laplace and Poisson's equation-solution, method of characteristics for solution of initial boundary value problems, relaxation method

#### **Unit 2: Numerical differentiation II:**

Finite Difference, Gaussian elimination and Gauss, Jordan methods, matrix inversion, Gauss Seidel method –Newton- Raphson method

#### **Unit 3: Statistics and Probability:**

Moments, Skewness and Kurtosis, Probability, conditional probability, various theoretical distributions like binomial, normal, log-normal, Poisson, gamma distribution, Pearson type I, II & II distribution test of significance, Gumbel distribution, testing of hypotheses – Large sample tests for mean and proportion, Chi-square test, errors, types of errors.

#### **Unit 4: Regression and Correlation:**

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design

#### **Unit 5: Transforms:**

Laplace Transformer: LT of standard function, inversions and their application in civil engg.  
Fourier Transformer: Fourier integral, Fourier transform and their application in civil engg.

#### **Unit 6: Matrix method and Finite element:**

Matrix method analysis (Stiffness) co ordinate calculation for different types of structure. Finite element method basics (1D and 2D) co ordinate calculations.

#### **Reference Books**

1. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
2. Venkatraman, M.K., Numerical Methods in Science and Engineering, National Publisher Company.
3. Numerical Methods by Krishna Raju
4. Shanthakumar M.S., Numerical Methods & Analysis

## Department of Technology

### SYLLABUS FOR MTech- Integrated MTech-PhD (Civil and Environmental Technology)

#### ADVANCED DESIGN OF CONCRETE STRUCTURES

##### **Unit 1: Design Loads and combinations:**

Calculations of design dead load, live load, wind load, snow load and loading combinations in accordance with the relevant Indian codes of practice (IS: 875-1987 (5 parts)). Seismic loadings, Loads resulting from uneven settlement, Blast load, Dash load/Collision of vehicle, Fire load, load due to soil pressure etc.

Introduction to Liquid induced loads for operational, for testing, internal pressure loads, thermally induced loads, Insulation loads etc.

##### **Unit 2: Analysis of RCC Slabs:**

Yield line theory for analysis of slabs, Various patterns of yield lines, Assumptions in yield line theory, Equilibrium and virtual work method of analysis, Design of various slabs such as rectangular, triangular, circular with various edge conditions , Design for limit state of strength and serviceability orthotropically reinforced slabs,

##### **Unit 3: Liquid Retaining Structures (Over Ground):**

Basic design philosophy. Analysis and design of single cell rectangular water tanks subjected to hydrostatic loading based on plate theory.

Design of overhead water tanks, Intz tanks

##### **Unit 4: Liquid Retaining Structures (Under Ground):**

Design of Under Ground Water Tank with Counterfort Retaining Wall, subjected to Surcharge, Basic design philosophy. Calculation of lateral earth pressure based on Rankine's theory. Analysis and design of RC gravity walls, cantilever walls.

##### **Unit 5: Foundation Design:**

Design of foundation system and Geotechnical design for Hydraulic Failure such as failure by uplift (buoyancy), failure by heave; failure by internal erosion; failure by piping. Design of Raft and Pile foundation.

##### **Unit 6: Ductile Detailing of RCC Structures:**

Ductile detailing as per IS: 13920.

##### **Course Outcomes:**

- 1: Students will be able to design eccentrically loaded and slender columns using SP 16 design charts and different types of foundations
- 2: Students will be able to design and detail cantilever retaining wall and understand the design principles of Counter fort retaining wall
- 3: Students will be able to apply design and detail circular slabs and domes
- 4: Students will be able to design rectangular and circular water tanks using IS code coefficients (IS 3370).
- 5: Students will be able to learn about prestressed concrete fundamentals and analyze pre and post tensioned beams.

### **Reference Books**

1. Pillai S U and Menon Devdas, Reinforced Concrete Design, TATA Mc-Graw hill publishing co. Ltd., New Delhi
2. B.C. Punmia, Ashok K. Jain, Arun K. Jain – Reinforced Concrete Structures Vol. II, Laxmi Publications, New Delhi
3. N.C. Sinha, S.K. Roy – Fundamentals of Reinforced Concrete, S. Chand & Co. Ltd, New Delhi
4. P.C. Varghese – Advanced Reinforced Concrete Design, Prentice Hall of India Pvt. Ltd., New Delhi
5. H.J. Shah– Reinforced Concrete, Vol I & II - Charotar Publishing House
6. Joseph E. Bowels – Foundation Analysis and Design-, TATA Mc-Grawhill
7. Nainan P Kurian – Design of Foundation Systems, Narosa publication house
8. M.J.Tamlinson – Foundation Design & Construction, ELBS publication
9. G. A. Leonards, Foundation Engineering, McGraw-Hill, 1962.
10. J.E. Bowles, Foundations Analysis and Design, 3rd Ed., McGraw-Hill, 1968.
11. R.B. Peck, W.E. Hanson and T.H. Thornburn, Foundation Engineering, 2nd
12. Fang , H.Y.,(1991),” Foundation Engineering Handbook”, Chapman & Hall,NY.



13. Teng .W.C.(1962), Foundation Design , Prentice Hall International.
14. IS: 456: Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi
15. IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi
16. IS:13920 – Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force, 1993
17. IS: 1904-1986, “Code of Practice for Design and Construction of Foundations in Soils, general Requirements”.
18. IS: 2911-1979, “Code of Practice for Design and Construction of Pile Foundation”

**S.P. Pune University**  
**M. Tech. (Civil and Environmental Technology)**  
**SEMESTER - I**

**CONSTRUCTION MANAGEMENT**

**Unit 1: Introduction:**

Traditional management and modern scientific management, Principles of management, Theories of Taylor, Fayol, Mayo, McGregor, Weber, Gilbreth. Project Management -Basic forms of organization. Construction scope, project management phases & processes, construction project Management practice, construction project manager's role & skills, major causes of project failure.

**Unit 2: Construction Planning and Scheduling:**

Construction Management & General Contracting , Project work breakdown levels, development methodology, WBS, Defining project activities & estimating activity durations. Scheduling – Bar chart, network scheduling, linear scheduling, and precedence network analyses with examples.

**Unit 3: Resource management and Cost control:**

Resource allocation, leveling, constraining, updating, earned value. Compression of network & Project cost.

**Unit 4: Construction Equipments:**

Construction Equipments – Understanding basics and functions of Equipment Earthmoving Machinery, Concreting Equipment, Material Handling Equipment and Transportation of Equipments.

**Unit 5: Equipment Management:**

Equipment Management, Costing, Optimum utilization and Equipment selection, depreciation, interest on capital, Manpower, Spare parts etc, Documentation, Log-Books, History Books.

**Unit 6: Construction safety:**

Accidents, types, primary accidents to be taken, legal formalities, safety policy, equipment safety.

**Lab:**

One assignment on each unit with special emphasis on use of software like MSP, Primavera etc., wherever required.

## **Course Outcomes:**

- 1 :** Students will able to plan and schedule a construction project.
- 2:** Students will able to select an appropriate construction equipment for a specific job.
- 3:** Students will able to learn the legal procedures in construction contracts
- 4:** Students will able to formulate suitable quality management plan for construction
- 5:** Students will able to explain the safety practices and procedures.
- 6:** Students will able to apply principles of ethics in decision making.

## **Reference Books**

1. Construction Project Management: Planning, Scheduling and Control by Chitkara, K.K., Tata McGraw-Hill Publishing Company, New Delhi, 1998
2. Project Planning, Scheduling and Control in Construction by Calin M. Popescu, Chotchai Charoenngam, An Encyclopedia of terms and Applications, Wiley, New York, 1995.
3. Project Management for Construction, Fundamental Concepts for Owners, Engineers, Architects and Builders by Chris Hendrickson and Tung Au, Prentice Hall, Pittsburgh, 2000.
4. Scheduling Construction Projects by Willis, E. M. John, Wiley & Sons, 1986
5. Financial and Cost Concepts for Construction Management by Halpin, D. W., John Wiley & Sons, New York, 1985.
6. Work study – Currie.
7. Roy, Pilcher Construction Management Construction Planning, Equipment and Methods by Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., McGraw Hill, Singapore, 2006.
8. Construction Equipment and Management by Sharma S.C., Khanna Publishers, New Delhi, 1988.

**S.P. Pune University**  
**M. Tech. (Civil and Environmental Technology)**  
**SEMESTER - II**

**FLUID MECHANICS**

**Unit 1: Introduction:**

Revision of concepts in basic Fluid Mechanics such as classification of flows, Equation of continuity for three dimensional flow in Cartesian co-ordinates, equation of continuity for one-dimensional flow along a streamline, types of motion, rotational and irrotational motion, velocity potential, stream function and flow net, Euler's equation of motion along a streamline and its integration, Bernoulli's equation. Development of boundary layer on a flat plate nominal, displacement, momentum, energy thicknesses, laminar, transitional and turbulent boundary layer, laminar sub layer, Local and mean drag coefficients

**Unit 2: Kinematics:**

Continuity Equation in polar and cylindrical coordinates, conformal mapping, Standard two dimensional flow pattern, source, sink, doublet

**Unit 3: Laminar Flow:**

Navier Stokes equation-derivation, flow between parallel plates-it's exact solution, Laminar flow through a circular pipe

**Unit 4: Boundary Layer Theory:**

Karman's momentum integral equation, Karman Pohlhausen's solution, boundary layer separation

**Unit 5: Turbulent Flow:**

Characteristics of turbulent flow, instantaneous velocity, temporal mean velocity, scale of turbulence and intensity of turbulence, Prandtl's mixing length theory, velocity distribution in turbulent flow- Prandtl's velocity distribution equation. Reynolds' equation of motion, typical solution, Energy and Momentum equation, Statistical theory of turbulence

**Unit 6: Fundamentals of Compressible Flow:**

Compressible fluid flow-fundamental equation, continuity equation, energy equation, velocity of propagation, Pressure, density and temperature in terms of Mach number,

Normal shock in one dimensional compressible flow and compressible flow around immersed bodies.

**Course Outcomes:**

- 1:** Students will be able to define basics of fluids in static, kinematic and dynamic equilibrium,
- 2:** Analyze the condition of stability of a body in a fluid based on relative positions of its center of buoyancy and metacenter
- 3:** Apply Bernoulli's equation to fluid problems,
- 4:** Analyze the flow through pipes and the major and minor losses
- 5:** Students will learn the concept of development of boundary layer over a long thin plate.

**Reference Books**

1. Fluid Mechanics and Hydraulic Machines – Sukumar Patil, Tata McGraw-Hill
2. Fluid Mechanics- Grade & Mirajgaonkar
3. Fluid Mechanics and Machinery- D. Ramadurgaiah, New age International
4. Boundary Layer Theory- H. Schlichting, Springer New-York 2000
5. Fluid Mechanics-Victor L Streeter & E.B. Wylie, Mc-Graw Hill
6. Fluid Mechanics-Frank M White, Mc-Graw Hill
7. Fluid Mechanics-Fundamentals and Applications- Cengel and Cimbala, McGraw-Hill 12

**S.P. Pune University**  
**M. Tech. (Civil and Environmental Technology)**  
**SEMESTER - II**  
**ADVANCED TOWN PLANNING ENGINEERING**

**Unit 1:**

**Current events and Technology:** Current events of national and international importance – Industrial, Economic, Spatial Planning, Urban Development, Technology - Applications of Total station, Drone, Remote sensing, GIS, GPS, Computer-Aided Design in Urban Planning.

**Theories of Planning:** Garden City Concept, Gedidian Trio Concept, Concentric zone model, Sector Theory, Multi-nuclei theory, Neighborhood Concept.

**Unit 2:**

**Regional Plan:** Need of Regional Plan, Delineation of Region, Types of Regions, Contents of Regional Plan, Surveys necessary for Regional Plan, Analysis and Projections, Process of preparation of Regional Plan as per provisions of MR and TP Act, 1966, Relation with State Plan and surroundings.

**Development Plan:** Difference between Structure Plan and Development Plan, Classification of Towns, Surveys, Analysis and Projections, Demographic projections, Goals and Objectives, Public participation, Implementation and financial aspects, Relation with Regional Plan, Contents of D.P., Planning norms, Modifications to sanctioned DP, Modifications of substantial nature, Notices under section 49 and 127, Process of DP preparation, publication, submission and approval as per provisions of MR and TP Act, 1966.

**Unit 3:**

**Town Planning Scheme:** Concept, Preparation of TP Scheme as per provisions of MR and TP Act, 1966, Relation with DP, Original Plot, Final Plot, Semi-final plot, Incremental contribution and rationale for charging it, Contents of TPS, Cost of TPS, Advance possession, Amenities partially beneficial, Functions of Arbitrator, Functions of Tribunal of Appeal.

**Local Area Plan:** Concept, Objectives, Delineation of LAP boundary, Methodology of preparation, Case studies in India, Provision in UDCPR

**Unified Development Control Regulations:** Procedure for obtaining development permission/building permission, Grant/ refusal of permission, deemed permission, Approvals on risk-based categorization, Commencement of works, General land development requirements, Land-Use Classification and equivalency of zones, concept of p-line, Ancillary FSI, TDR, AR, Reservation Credit Certificate, Removal of difficulties, Redevelopment of old dilapidated/dangerous buildings, housing for EWS/LIG, Incentive for green buildings, Off-street

parking requirements, Affordable housing, Voluntary TP Schemes, Heritage list card, premiums and their payment, Integrated Township, Transit oriented development

**Development Charges and Appeal:** Development charges, Revocation of permission, Provisions of appeal under section 47 and 124, Actions against unauthorized development.

**Transportation:** Transportation Studies, Origin and Destination, traffic volume survey, modal split, transport System.

**Environment:** Environment Clearance, Environmental Impact Assessment

#### **Unit 4:**

**Acts and Rules:** Maharashtra Regional Town Planning Act, 1966 and rules thereunder, Bombay Stamp Act, 1958, Maharashtra Land Revenue Code, 1966, Environment Protection Act, 1986, Maharashtra Municipal Corporations Act, 1949, 73<sup>rd</sup> and 74<sup>th</sup> Constitutional Amendment Act, Maharashtra Municipal Councils, Nagar Panchayats and Industrial Townships Act, 1965, Evolution of Planning Legislation in India

**Land Acquisition:** Need of compulsory acquisition, Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, Functions of Land Acquisition officer.

#### **Unit 5:**

**Valuation:** Value, Cost, Price, Purposes of Valuation, Special Characteristics of landed property, Supply and demand of landed property, Interests in landed property, Forms of Value, Forms of rent, Capitalised value, Year's purchase, Outgoing, Depreciation, sinking fund, reversionary value.

**Valuation Tables:** Meaning and utilities of valuation tables, Amount of Rs. 1/-, Present value of Rs 1/-, Amount of Rs.1/- p.a., Present value of Rs.1/-p.a., Annuity of Rs.1/-, Sinking fund, Single and dual rate table-concepts.

#### **Unit 6:**

**Methods of Valuation:** Comparative methods, Market Approach, Contractor's method, Investment method, Belting method

**Annual Statement of Rates:** True Market Value, Procedure for preparation of Annual Statement of Rates, Valuation for bulk land

#### **Course Outcomes:**

- 1:** State the objectives and principles of town planning, planning theories.
- 2:** Discuss different planning standards for the physical planning of a town, ASR and Valuation of property.
- 3:** Describe the spatial aspects of planning for rural and urban settlements and MRTP Act 1966.

**4:** Discuss the different levels in planning like development plan, regional plan with their characteristic.

**5:** Explain different types of landscaping with application in modern and historical eras, use of UDCPR and valuation tables.

**6:** Locate and prepare the layout plans, local area plan, Existing land use map/ plan (ELU), neighborhood plans, town planning schemes for the different case studies

### **Reference Books**

1. "Town Planning" by Rangwala
2. "Principles Of Town Planning And Architecture" by Biswas Hiranmay
3. "Architecture and Town Planning" by Joyce Oron and Netanel Osnat Semrik
4. "The City of Tomorrow and Its Planning" by Le Corbusier
5. "Research Design in Urban Planning: A Student's Guide" by Stuart Farthing
6. "Ancient Town-Planning" by F Haverfield
7. "Application of Computer Aided Design to Town Planning Practice" by Kilanko Tolulope G



**S.P. Pune University**  
**M. Tech. (Civil and Environmental Technology)**  
**SEMESTER - II**

**DESIGN OF WATER & WASTEWATER TREATMENT SYSTEMS**

**Unit I:**

Estimation of water demand based on population projection. Designs of source intakes, raw water pumping main, economic design of rising main, determination of storage capacity of reservoirs.

**Unit II:**

Raw Water Characteristics, Flow charts for WTPS wrt various sources, Theory & Design of Aeration System – Cascade Aerator; Theory & Design of Plain ST & Clari-flocculator; Tube Settlers.

**Unit III:**

Filtration: Theory & Design; Disinfection: Theory & design

**Unit IV:**

Sewage generation, Collection and Transmission: Theory & Design; . Wastewater Characteristics; Theory & design of primary units: Screen Chamber, Grist Chamber. PST

**Unit V:**

Principles & design of Biological Treatment Units: ASP, TF, OP, MAL;

**Unit VI:**

Theory of UASB; On-site sanitation for rural areas: two pit latrines; ST followed by leach pit / soak pit / dispersion trenches.

**Course Outcomes:**

- 1:** Compute discharges and design layout of storm water drain for a given catchment and sewer network for given population
- 2:** Describe the physical, chemical and biological characteristics of waste water and understand the objectives and steps of preliminary treatment of waste water
- 3:** Describe the purpose and steps in secondary treatment of waste water by biological methods

**4:** List the characteristics of solid waste and propose different low cost waste water treatment methods

**5:** Characteristics & disposal of solid wastes/ Sludge.

**6:** Illustrate different methods of industrial waste treatment.

### **Reference Books**

1. Weber, W.J., Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.
2. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. Environmental Engineering, McGrawHills, New York 1985.
3. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw-Hill Publication, New Delhi, 2003
4. Water & Waste Water Engineering by Fair and Gayer. C.A. Sastry, Water TreatmentPlants, Narosa Publishing House, Bombay, 1996.
5. CPHEEO Manuals on Water Treatment and Sewerage & Sewage Treatment – MoEF, GoI, New Delhi

## **M.Tech. (Civil and Environmental Engineering)**

### **SEMESTER I**

#### **Elective 1**

### **Dam Engineering**

#### **Module 1**

##### **Reservoir Planning**

Types, developments, Storage and diversion works, Purpose: Single and multipurpose,

Investigation for locating a reservoir, Selection of site, estimation of required storage, mass curves, reservoir losses, reservoir operation, economics of reservoir planning, benefit cost ratio, price escalation of projects

#### **Module2**

##### **Dams**

Introduction, Classification of dams based on function, hydraulic design, materials of construction, Choice of type of dam, selection of dam site, site investigations, sunsurface explorations

#### **Module3**

##### **Gravity Dams:**

Forces acting on the gravity dams earthquake force-pseudostatics and dynamic response approach, load classifications, stability analysis, distribution of shear and normal stresses, principle stresses, Stress concentration around openings, foundation treatments, Design of concrete dam.

#### **Module 4**

##### **Earthen Dams:**

Seepage through dam and its foundations, stability analysis for sudden drawdown condition, steady seepage condition, end of constructions, seismic effects, pore pressures, protection of upstream and downstream slopes.

#### **Module 5**

##### **Arch Dams**

Arch dams-General concepts of trail load theory, elastic shell methods, thick cylinder theory

##### **Buttress Dam and Rock fill Dams:**

Relevant rock fill characteristics, general design principal method of construction and compaction.

Buttress dam- Concepts and Design

## **Module 6**

### **Spillways-**

Spillway-types, components, design principles, Design of different spillways such as Ogee, side channel, siphon. Energy dissipation devices and their design

### **Reference Books**

1. Concrete Dams – R.S. Varshney
2. Irrigation Water Resources & Water Power Engineering P.N. Modi
3. Earth Dams – J.L. Sherard
4. Water resources Engineering Principles and Practice- S. Murty Challa- New Age International
5. Elements of water resources engineering – K.N.Duggal, J.P.Soni, New Age International

**Elective I**  
**Mechanics of Waves**

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**Module 1**

Introduction, Generation, Decay, Classification, Measurement, Wave Forecasting: The Significant Wave, Simplified versus Elaborate Technique, Simplified Methods- SMB method, Hasselmann method, Darbyshire and Draper's Technique, Forecasting in Hurricanes, Numerical Wave Modeling (introduction only, no mathematical treatment): Phase resolving models, Phase averaging models

**Module 2: Wave Theories**

Basic hydrodynamic equations, wave theories - Linear wave theory, Finite amplitude wave theories (introduction only, no mathematical treatment): Stokes, wave theory, Cnoidal wave theory, Solitary wave theory, Dean stream function theory, Trochoidal wave theory, Non-linear versus linear wave theory, Choice of wave theory

**Module 3: Random waves**

Wave spectrum analysis, wave spectra and statistics, Theoretical spectra: Pierson-Muskowitz Spectrum, Bretschneider Spectrum, JONSWAP Spectrum, Scott Spectrum, Scott-Wiegel Spectrum

Wave statistics: Short term wave statistics, Tucker method, Long term wave statistics- Gumbel distribution, Weibull Distribution, Log Normal Distribution, Fretchet Distribution, Upper bound Type III u distribution,

Long Term Distribution of Individual Wave Heights

**Module 4: Wave propagation**

Wave shoaling, wave refraction, wave diffraction, wave reflection, combined effects using numerical solutions, wave breaking, wave set up and set down, wave runup

**Module 5: Wave Forces On Shore-Based Structures**

Forces on Vertical Faced Structures: Non- breaking wave forces, breaking wave forces, forces by broken waves, forces on Seaward structures, forces on landward structures, oblique wave attack. Forces on sloping face structures: Single rubble mound, composite breakwater

**Module 6: Wave Force On Small Diameter Members**

The Morison's equation, Total Wave Force On The Entire Member Length, Wave Forces Using Stokes (V) Theory, Calculation Of Wave Forces Using Dean's Theory, Wave Force On Inclined Members (introduction only-rigorous mathematical treatment to be avoided), Wave Slam, Limitations of the Morrison's Equation

**Books:**

Sarpkaya, T., Issacson, M. (1981). "Mechanics of Wave Induced Forces on Offshore Structures", Van Nostrand Reinhold.

U.S. Army Corps of Engineers. (2002). "Coastal Engineering Manual", U.S. Army Corps of Engineers, Washington, D.C.

WMO. (1988). "Guide to Wave Analysis and Forecasting", Pub. NO. 702, World Meteorological Organization, Secretariat of WMO, Geneva.

Dean, R. G., Darlymple R. A. (1991). "Water Wave mechanics for Engineers and Scientists", World Scientific

Sorensen, R. M. (1997). "Basic Coastal Engineering", Springer

## **Elective I**

### **Remote sensing and GIS in WRE**

#### **Module 1 Concept of remote sensing:**

Electromagnetic energy, Interaction of EMR with Atmosphere and earth material, atmospheric windows, EMR spectrum, platform, sensor types, MSS. Aerial Remote Sensing:- Flight planning, types of Aerial photographs,. Photogrammetry: stereoscopic vision, scale, relief displacement, parallax, vertical exaggeration.

#### **Module 2 Satellite Remote Sensing:**

LANDSAT and IRS characteristics, products and FCC, Interpretation Techniques, visual and digital in brief, Recognition of photo elements and terrain elements like size, shape, tone, texture, pattern, shadow etc, Terrain analysis: Relief, landform, drainage pattern

#### **Module 3**

Use of remote sensing in Lithology, structure and Geomorphology Application of Remote Sensing in Ground Water and Mineral Exploration, Basic Concept of GIS, components, history and applications, Hardware and Software requirements for GIS, Map features, Scale, Resolution, accuracy and data base extent

#### **Module 4 Map projection and parameters:**

Geographical Coordinate system, types of projection and parameters, projection transformation and mapping in GIS. Geospatial data models: Spatial and non-spatial data, VECTOR and RASTER models.

**GIS Analysis:** Digitalization, editing and structuring of map data, overlay analysis, Digital elevation and terrain model (DEM / DTM), buffer analysis and query analysis, Introduction to GPS and their applications with limitations, Applications of GIS in Environmental Engineering

#### **Reference Books**

1. Remote sensing methods & applications – R. Michael Hord, Wily Interscience Publication.
2. Remote sensing & image interpretation – Lilleson J.T.M. & Krefer R.W. Wiely, New York.
3. Photogrammetry by – Sheford
4. Remote sensing in Civil Engineering – J.M. Kennie & M.C. Mathews.

## Elective II

### Planning and Management of Water Resources

#### Module 1

##### Introduction:

Objectives: of water resource planning and management, its Necessity, Aspects of water resources planning, water resource development; needs and opportunities; social goals.

#### Module 2

constraints in the development of planning and management of water resources like non reversibility; planning region and horizon. Demand for drinking water; irrigation, hydropower; navigational; planning for flood control.

#### Module 3

**Reservoir operation studies** - Characteristics and functions of reservoir; reservoir sedimentation; conservation storage; conflict among uses. Effect on river regime; long term simulation; reliability; resiliency and vulnerability assessment

#### Module 4

**Management of Ground-Water Resources:** Ground water evaluation; conjunctive use of surface and ground water. Basin planning; inter-basin transfer of water.

#### Module 5

Cost benefit studies of single and multipurpose projects– multi objective planning models, financial analysis of water resources projects.

#### Module 6

**Economic Planning:** Allocation of cost of multipurpose projects; repayment of cost. Discounting techniques; benefit cost parameters; estimation of benefits and costs; appraisal criteria; social benefit cost analysis.

#### Reference Books

1. James, L .D., and Lee, R. R., “Economics of Water Resources Planning”, Mc Graw Hill.
2. Principles of Water Resources planning-by Goodman.



3. Water Resources System Planning – by M.C. Chaturvedi.
4. Water Resources Planning and Management by-O.J. Helwege.
5. Water Management System Application-A.K. Biswas
6. Water resource Engineering- Linsley and Franzini, Mc Graw-Hill
7. Water resources planning and management- Grafton and Hussey, Cambridge Uni. Press.

**Elective II**  
**Optimization Techniques**

**Unit 1**

**System Concepts:** System concepts, definitions, needs for system approach, different types of system parameters and variables.

**Unit 2**

**Linear Programming:** Revision, Big M Method, duality, sensitivity analysis. Application of Linear Programming for Hydraulics & Water Resource

**Unit 3**

**Non Linear Programming:** Unconstrained one Dimensional search methods, Dichotomous search method, Fibonacci, Golden section, multivariable unconstrained, gradient techniques, steepest ascent and descent methods, Newton's methods, Application of Dichotomous search method, Fibonacci & Golden section to the various sectors of Water Resource Engineering, constrained Lagrangian multiplier techniques

**Unit 4**

**Dynamic Programming:** Principle of optimality, recursive equations. Application of Dynamic programming to Water Resource Engineering

**Unit 5**

**Stochastic Methods:** Queuing theory, simulation technique, sequencing model, Morkov's process

**Unit 6** Theory of games, 2 person zero sum game with and without saddle point, mixed strategies (2 x n games or m x 2 games), 2 x 3 game with no dominance, graphical method

**Reference Books**

1. Engineering Optimazation Theory & Practice – S.S. Rao., Wiely.
2. Operation Research – Taha Hamdey A.
3. Principles of Operation Research – Wagner, Prentice Hall.
4. Operation Research – Hira and Gupta, S.Chand

**Elective III**  
**Open Channel Flow**

**Module 1**

**Uniform flow**-Review and revision of uniform flow formulae and design of channels, Depth-energy relationship, specific energy, specific force, Critical flow, critical flow computations

**Module 2**

**Gradually Varied Steady Flow:**

Gradually varied steady flow and rapidly varied steady flow in open channels, surface profiles in GVF analysis, Different method of computations, Chow's methods, standard step method, and finite difference method

**Module 3**

**Rapidly varied flow--Hydraulic Jump:**

Formations of jump in expanding and contracting channel, jump type, jump control, jump on sloping floors,

**Module 4**

**Spatially Varied Flow:**

Differential Equation of spatially varied flow, profile computation, SVF with lateral inflow.SVF with lateral outflow

**Module 5**

**Unsteady Flow:**

Gradually varied unsteady flow: Continuity equation, dynamic equation, Monoclonal rising waves,dynamic equation for uniformly progressive flow, wave profile of uniformly progressive flow, wave propagation, Rapidly varied unsteady flow: Uniformly progressive flow, positive surge, negative surge, dam break problem

**Module 6**

**Flood Routing:**

Hydraulic and Hydrologic flood routing, Reservoir and channel routing, Differential form of

Momentum Equation, Muskingum method, Finite difference scheme, Method of characteristics.

### **Reference Books**

1. Open Channel Hydraulics – Ven Te Chow, Mc-Graw Hill.
2. Flow through Open Channel-K.G.Ranga Raju, Tata Mc-Graw Hill.
3. Flow in Open Channel – K. Subramanya, Tata Mc-Graw Hill.
4. Flow through open channels—Rajesh Srivastava—Oxford University Press
5. Open Channel Hydraulics-French, Mc-Graw Hill.

## **Elective III**

### **Irrigation and Drainage**

#### **Module 1**

##### **Soil water Relationships**

Water storage zones and relative equilibrium states, flow of water in saturated and unsaturated soil, soil moisture determination

#### **Module 2**

##### **Water-Soil Plant Relationships**

Evaporation, transpiration, consumptive use, Salinity and Alkalinity in irrigated soil, Soil Erosion and conservation

#### **Module 3**

##### **Drip Irrigation**

General concept, advantages, disadvantages, elements, design concepts

#### **Module 4**

##### **Lift Irrigation :**

General concept, elements of lift irrigation schemes, design consideration involved in intake well, jackwell, rising main, distribution system, concept of cost economics.

#### **Module 5**

##### **Sprinkler Irrigation**

General concept, advantage and disadvantages, components of the system, types of Sprinklers, design concept

#### **Module 6**

##### **Drainage of Irrigated Land**

Need and purpose of drainage, water logging, design and construction of drainage systems, Ministry of agriculture- WMD recommendations.

#### **Reference Books**

1. Irrigation, Water Resources & Water Power Engineering, P.N. Modi
2. Irrigation Engineering Theory & Design – R.S. Varsheny.

## **Elective IV**

### **Sediment Transport & River Mechanics**

#### **Module 1**

##### **Introduction**

Introduction fluvial hydraulics, Definition of sediment, Origin and formation of sediments, Nature of sediment problems, fundamental properties of individual sedimentary particles, Concept of fall velocity, Bulk properties of sediment

#### **Module 2**

##### **Incipient Motion**

Approaches of establishment of incipient motion, Shields analysis, Regimes of flow – study of different bed forms like ripples, dunes, anti - dunes with characteristics, significances, resistance analysis

#### **Module 3**

##### **Sediment Transport**

Modes of sediment transport, Introduction to different bed load equations – empirical, dimensional and semi-theoretical equations. Detailed study of DuBoys' equation, Einstein equation, Meyer-Peter and Müller equation. Concept of suspended load, total load, wash load.

#### **Module 4**

##### **Stable Channel Design**

Concept of stable channel, Design procedures such as Kennedy method, Lacey's method. Brief introduction of other methods such as Bunch, Simmon- Albertston method, Tractive force approach

#### **Module 5**

##### **Sediment Measurements**

Measurement of bed load and suspended load , Plan forms of river bends, Channel characteristics, bifurcations, confluences, river gauging, continuity Equation for sediment, stream bed changes during Floods, Silting of reservoir

#### **Module 6**

##### **River Training Works**

Objective of river training and bank protection, River training for flood control, navigation, Guiding the flow, sediment control, River bank protection, Introduction to sediment transport through pipes, Introduction to alluvial river models

### **Reference Books**

- 1 Yang. C.T. "Sediment Transport theory and Practice " McGraw –Hill , New-York, 1996
2. Graf, W.H. "Hydraulics of Sediment Transport", McGraw –Hill , New-York,1971
3. Raudkivi, A.J. "loose Boundary Hydraulics"2nd edition, Pergamon Press, 1976
4. F.M.Hendorson," Open Channel Flow "Mac Millon , New York , 1996
5. Grade, R.J. and Ranga Raju, K.G."Mechanics of Sediment Transport and Alluvial Stream Problems" New Age International (P) Ltd. Publications, New Delhi , 2006.



## **Elective IV**

### **Hydrology**

#### **Module 1**

##### **Introduction:**

Hydrologic Cycle, Precipitation, Evaporation, Infiltration, Interception and Depression, Depth area duration analysis, Unit hydrograph theory, IUH. Stochastic processes-classification, time series & it's components

#### **Module 2**

##### **Flow Generation**

Various statistical distributions like binomial, normal, log-normal, Poisson, Beta B, gamma, Pearson type I, II and III & their uses in hydrology, Chi square test, plotting, position, frequency factors, extreme value theory, synthetic generation of yearly and monthly flows in hydrology.

#### **Module 3**

##### **Frequency analysis of hydrologic events**

Frequency analysis, Frequency distribution models Flood estimation by various methods, forecasting of floods, flood frequency analysis, Gumbel's, Pearson type I, II, and III distribution, Log-normal method, design flood for various hydraulic structures and flood routing.

#### **Module 4**

##### **Groundwater Hydraulics and its Development:**

Introduction of Ground Water Hydraulics, aquifers, vertical distribution of subsurface water, Darcy's Law-its range of validity, Dupuit's assumption, application of Darcy's law to simple flow systems governing differential equation for confined and unconfined aquifers.

#### **Module 5**

##### **Well hydraulics:**

Definition of wells, types of wells, differential equation for fully & partially penetrating wells, interference of wells, pumping test with steady & unsteady flow, method of image. Well Exploration, well construction & design, screens, perforations & gravel Packs.

#### **Module 6**

##### **Groundwater Conservation and modeling techniques**

Ground water budget, seepage from surface water artificial recharge, Porous media models, Analog models, Electric analog models, Digital computer models and their applications

### **Reference Books**

1. Applied Hydrology-Linsley Kolhar & Paulhas (Mc-Graw Hill)
2. Water Resource & Hydrology-S.K. Garg.
3. Engineering Hydrology-K. Subramanya, Tata Mc-Graw Hill.
4. Elementary Engineering Hydrology—M.J.Deodhar--- Pierson Edution
4. Hydrology- H.M. Raghunath, Wily Eastern, New Delhi.
5. Stochastic Hydrology-Jaya Rami Reddy, Laxmi Pub., New Delhi.
6. Applied Hydrology-V.T. Chow, McGraw-Hill Book Company.
7. A text book of Hydrology- Jaya Rami Reddy, University Science Press
8. Ground water Hydrology---D.V.Todd---Wiley,India.
- 9 Numerical Groundwater Hydrology-----A.K.Rastogy.---Penram Internal Publishing(India).

## Elective IV

### Ground Water Modeling

#### Unit 1

**Groundwater Occurrence & Movement:** General Introduction, Darcy's law, application of Darcy's law to confined and unconfined aquifers, wells - fully & partially penetrating wells, multiple wells, interference of wells, pumping test with steady and unsteady flow

#### Unit 2

**Surface and sub-surface investigation of ground water:** Geological/geophysical exploration/remote sensing/electric resistivity/seismic refraction based methods for surface investigation of ground water, test drilling and ground water level measurement

Sub-surface ground water investigation through geophysical/resistivity/ spontaneous potential/radiation/temperature/caliper/fluid conductivity/fluid velocity/miscellaneous logging

#### Unit 3

**Planning of groundwater development:** Water balance, assessment of recharge, utilizable recharge, Groundwater estimation norms in India, Constraints on groundwater development, Planning of ground water development in canal command areas-conjunctive use models, planning of ground water development in coastal aquifers

#### Unit 4

**Numerical modeling of groundwater flow:** Ground water modeling through porous media/analog/electric analog/digital computer models; Review of differential equations, finite difference solution, direct problem, inverse problem; groundwater modeling using finite element method

Artificial ground water recharge: Concept, methods of artificial ground water recharge, waste water recharge for reuse, water spreading

#### Unit 5

**Management of Ground Water:** Ground water basin management concept, hydrologic equilibrium equation, ground water basin investigations, data collection & field work, dynamic equilibrium in natural aquifers, management potential & safe yield of aquifer, stream-aquifer interaction

## **Unit 6**

**Saline water intrusion in coastal aquifers:** Ghyben-Herzberg relation between fresh & saline waters, shape & structure of fresh & saline water interface

Upcoming of saline water, fresh-saline water relations on oceanic islands, sea water intrusion in Karst terrains, saline water intrusion control

### **Reference Books**

1. Remson, I., Hornberger, G.M., and Molz. F.J., Numerical methods in sub-surface hydrology, Wiley Inter Science.
2. Rushton, K.R. and Redshaw, S.C., Numerical analysis by analog & digital methods, John Wiley.
3. Todd, D.K., Groundwater Hydrology, John Wiley, 1980.
4. Groundwater Modeling by Anderson.
5. Numerical ground water modeling by A K Rastogi, Penram International Publishing (India) Pvt Ltd. 2007