

**Programme Requirement Table**  
**Department of Civil Engineering**  
**M. Tech (Water Resources Engineering)**  
**Year of Admission 2009**  
**Overall Credit Structure**

| Post graduate core (PC)          |              | Postgraduate Electives (PE) |              |
|----------------------------------|--------------|-----------------------------|--------------|
| Category                         | Credit       | Category                    | Credit       |
| DC                               | 68-74        | DE                          | 30-36        |
|                                  |              |                             |              |
| <b>Total</b>                     | <b>68-74</b> | <b>Total</b>                | <b>30-36</b> |
| <b>Grand Total (PC + PE) 104</b> |              |                             |              |

| Course Code                       | Course                                       | Structure | Credits |
|-----------------------------------|--|-----------|---------|
| <i>Departmental Core, DC</i>      |  |           |         |
| MAL 402                           | Numerical solution of Differential Equations | 3-0-0     | 6       |
| CEL 426                           | Groundwater Hydrology                        | 3-0-0     | 6       |
| CEL 427                           | Free Surface Flows                           | 3-1-0     | 8       |
| CEL 428                           | Water Resources Systems                      | 3-0-0     | 6       |
| CEL 412                           | Spatial Analyses for Resources Management *  | 3-0-2     | 8       |
| CEL 514                           | Applied Surface Hydrology                    | 3-0-0     | 6       |
| CEP 503                           | Water Resources Engineering Laboratory       | 0-0-4     | 4       |
| CED 501                           | Project Phase I                              | 0-0-0     | 6       |
| CED 502                           | Project Phase II                             | 0-0-0     | 18      |
|                                   |  |           | 68      |
| <i>Departmental Electives, DE</i> |  |           |         |
| CEL 429                           | Close Conduit Flows                          | 3-0-0     | 6       |
| CEL 419                           | River Engineering                            | 3-0-0     | 6       |
| CEL 414                           | Water Distribution Systems                   | 3-1-0     | 8       |
| CEL 430                           | Hydraulic Structures I *                     | 2-1-0     | 6       |
| CEL 420                           | Earthen Dams *                               | 3-1-0     | 8       |
| CEL 515                           | Advanced Fluid Mechanics                     | 3-0-0     | 6       |
| CEL 516                           | Modeling Techniques *                        | 3-0-0     | 6       |
| CEL 517                           | Hydraulic Structures II                      | 2-1-0     | 6       |
| CEL518                            | Coastal Engineering *                        | 3-0-0     | 6       |
| CEL431                            | Water Quality Modeling *                     | 3-0-0     | 6       |
| CE                                | Mini Project                                 | 0-0-0     | 4       |
| CE                                | Seminar                                      | 0-0-0     | 2       |
| CEL 432                           | Environmental Impact Assessment              | 3-0-0     | 6       |
| CEL 433                           | Water Power Engineering                      | 3-0-0     | 6       |
| CEL 406                           | Advanced Concrete Technology                 | 3-0-0     | 6       |
|                                   |  |           | 36      |

\* Subject to approval from Senate.

**Course Content Proforma**

**Department :**

|  |  |                   |                 |                    |  |
|--|--|-------------------|-----------------|--------------------|--|
| Course No.   | MAL402                                       | Open Course (Y/N) | HM Course (Y/N) | Discontinued (Y/N) |  |
| Course Title   | Numerical solution of Differential Equations |                   |                 |                    |  |
| Course Coordinator   |  |                   |                 |                    |  |
| Slot in which offered. If not offered write N                    | Odd  |                   | Even            |                    |  |
|  | G  |                   |                 |                    |  |
| Structure  | Lecture                                      | Tutorial          | Practical       | Credits            |  |
|  |  |                   |                 |                    |  |
| Prerequisite Course Codes<br>As per proposed Course Numbers      |  |                   |                 |                    |  |
| Prerequisite credits   |  |                   |                 |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses |  |                   |                 |                    |  |
| Overlap course codes<br>As per proposed Course Numbers           |  |                   |                 |                    |  |
| Text Book<br>( Max. 2)   | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Edition                                      |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Edition                                      |                   |                 |                    |  |
| Reference Books  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Edition                                      |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Edition                                      |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
| Author   |  |                   |                 |                    |  |
| Publisher  |  |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
|  | Publisher                                    |                   |                 |                    |  |
|  | Edition                                      |                   |                 |                    |  |
|  | Title  |                   |                 |                    |  |
|  | Author                                       |                   |                 |                    |  |
| Publisher  |  |                   |                 |                    |  |
| Content  |  |                   |                 |                    |  |
| Course No.   |  |                   |                 |                    |  |

**Department : Civil Engineering**

|  |                       |                                 |                       |                    |  |  |
|--|-----------------------|---------------------------------|-----------------------|--------------------|--|--|
| Course No.   | CEL426                | Open Course (Y/N)               | HM Course (Y/N)       | Discontinued (Y/N) |  |  |
| Course Title   | Groundwater Hydrology |                                 |                       |                    |  |  |
| Course Coordinator   | Prof. A. D. Vasudeo   |                                 |                       |                    |  |  |
| Slot in which offered. If not offered write N                                    | Odd                   |                                 | Even                  |                    |  |  |
|  | C                     |                                 |                       |                    |  |  |
| Structure  | Lecture               | Tutorial                        | Practical             | Credits            |  |  |
|  | 3                     | 0                               | 0                     | 6                  |  |  |
| Prerequisite Course Codes<br>As per proposed Course Numbers                      |                       |                                 |                       |                    |  |  |
| Prerequisite credits   |                       |                                 |                       |                    |  |  |
| Equivalent Course Codes. As per proposed courses and old courses                 |                       |                                 |                       |                    |  |  |
| Overlap course codes<br>As per proposed Course Numbers<br>Text Book<br>( Max. 2) | Title                 | Groundwater Hydrology           |                       |                    |  |  |
|  | Author                | David Reith Todd,               |                       |                    |  |  |
|  | Publisher             | John Wiley publishers           |                       |                    |  |  |
|  | Edition               | 2002                            |                       |                    |  |  |
|  | Title                 | Groundwater & Well Hydraulics , |                       |                    |  |  |
|  | Author                | Ragunath H M                    |                       |                    |  |  |
|  | Publisher             | Wiley Eastern Ltd, New Delhi    |                       |                    |  |  |
|  | Edition               | 2000                            |                       |                    |  |  |
|  | Reference Books       | Title                           | Groundwater Hydrology |                    |  |  |
|  |                       | Author                          | Freeze & Chezy        |                    |  |  |
| Publisher  |                       | John Wiley publishers           |                       |                    |  |  |
| Edition  |                       |                                 |                       |                    |  |  |
| Title  |                       |                                 |                       |                    |  |  |
| Author   |                       |                                 |                       |                    |  |  |
| Publisher  |                       |                                 |                       |                    |  |  |
| Edition  |                       |                                 |                       |                    |  |  |
| Title  |                       |                                 |                       |                    |  |  |
| Author   |                       |                                 |                       |                    |  |  |
| Publisher  |                       |                                 |                       |                    |  |  |
| Edition  |                       |                                 |                       |                    |  |  |
| Title  |                       |                                 |                       |                    |  |  |
| Author   |                       |                                 |                       |                    |  |  |
| Publisher  |                       |                                 |                       |                    |  |  |
| Edition  |                       |                                 |                       |                    |  |  |

|            |  |
|------------|--|
| Content    | <p>Introduction : Occurrence of ground water, geological formations as aquifers; types of aquifers.</p> <p>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.</p> <p>Well hydraulics : Steady flow in confined, semi-confined and unconfined aquifers, radial flow, superposition; multiple well system. Different methods of well construction; construction of well casings and screens, natural and artificial gravel packed wells. Safe yields, estimation, pumping and recuperation tests.</p> <p>Two dimensional flow, methods of solution, infiltration galleries, Ground-water replenishment, recharge of ground water, different methods.</p> <p>Salt water intrusion : Concept; interface and its location; control of intrusion.</p> <p>Pollutant transport : Plume Transport, source identification, tracer methods.</p> |
| Course No. | CEL427   |

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|   |                                  |                              |                         |                    |  |  |
|---|----------------------------------|------------------------------|-------------------------|--------------------|--|--|
| Course No.  | CEL427                           | Open Course (Y/N)            | HM Course (Y/N)         | Discontinued (Y/N) |  |  |
| Course Title  | Free Surface Flows               |                              |                         |                    |  |  |
| Course Coordinator  | Dr A D Ghare                     |                              |                         |                    |  |  |
| Slot in which offered. If not offered write N                                 | Odd                              |                              | Even                    |                    |  |  |
|   | B                                |                              |                         |                    |  |  |
| Structure   | Lecture                          | Tutorial                     | Practical               | Credits            |  |  |
|   | 3                                | 1                            | 0                       | 8                  |  |  |
| Prerequisite Course Codes As per proposed Course Numbers                      | Fluid Mechanics II ( old scheme) |                              |                         |                    |  |  |
| Prerequisite credits  |                                  |                              |                         |                    |  |  |
| Equivalent Course Codes. As per proposed courses and old courses              |                                  |                              |                         |                    |  |  |
| Overlap course codes As per proposed Course Numbers<br>Text Book<br>( Max. 2) | Title                            | Flow Through Open Channel    |                         |                    |  |  |
|   | Author                           | Ranga Raju K. G.             |                         |                    |  |  |
|   | Publisher                        | Tata McGraw Hill Publication |                         |                    |  |  |
|   | Edition                          | 2003                         |                         |                    |  |  |
|   | Title                            | Flow in open channels,       |                         |                    |  |  |
|   | Author                           | Subramaya K.                 |                         |                    |  |  |
|   | Publisher                        | Tata McGraw Hill Publication |                         |                    |  |  |
|   | Edition                          | 2002                         |                         |                    |  |  |
|   | Reference Books                  | Title                        | Open Channel Hydraulics |                    |  |  |
|   |                                  | Author                       | Ven Te Chow             |                    |  |  |
| Publisher   |                                  | McGraw Hill Publication      |                         |                    |  |  |
| Edition   |                                  | 1996                         |                         |                    |  |  |
| Title   |                                  |                              |                         |                    |  |  |
| Author  |                                  |                              |                         |                    |  |  |
| Publisher   |                                  |                              |                         |                    |  |  |
| Edition   |                                  |                              |                         |                    |  |  |
| Title   |                                  |                              |                         |                    |  |  |
| Author  |                                  |                              |                         |                    |  |  |
| Publisher   |                                  |                              |                         |                    |  |  |
| Edition   |                                  |                              |                         |                    |  |  |
| Title   |                                  |                              |                         |                    |  |  |
| Author  |                                  |                              |                         |                    |  |  |
| Publisher   |                                  |                              |                         |                    |  |  |
| Edition   |                                  |                              |                         |                    |  |  |

|            |  |
|------------|--|
| Content    | <p>Review of uniform flow formulae and computation of uniform flow, critical flow, specific force, Boundary shear stress, compound channel section</p> <p>Theory of gradually varied flow, Dynamic equation in various forms, hydraulic exponents N and M, types of surface profiles and their classification. Analysis of surface profiles, Computation of gradually varied flow, different methods of computation – Bresse's and Chow's method of direct integration, Direct step and standard step method, Graphical integration method, Numerical methods.</p> <p>Rapidly varied flow : Flow over spillways. Theory of hydraulic jump, length and location of hydraulic jump, jump in sloping channel, applications of hydraulic jump, transitions. Theory of spatially varied flow : Dynamic equation with increasing discharge and decreasing discharge, computation of profile</p> <p>Unsteady flow in open channels: Fundamental equations of unsteady flow in open channels, waves and their classification, Saint Venant equations, celerity of a wave, surges, dam-break problem, flood routing</p> |
| Course No. | CEL427   |

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### Course Content Proforma

**Department :** Civil Engineering

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|--|-------------------------|----------------------------------|---|--------------------|--|
| Course No.   | CEL428                  | Open Course (Y/N)                | HM Course (Y/N)                         | Discontinued (Y/N) |  |
| Course Title   | Water Resources Systems |                                  |   |                    |  |
| Course Coordinator   | Prof. A. D. Vasudeo     |                                  |   |                    |  |
| Slot in which offered. If not offered write N                                    | Odd                     |                                  | Even                                    |                    |  |
|  |                         |                                  | E                                       |                    |  |
| Structure  | Lecture                 | Tutorial                         | Practical                               | Credits            |  |
|  | 3                       | 0                                | 0                                       | 6                  |  |
| Prerequisite Course Codes<br>As per proposed Course Numbers                      | Irrigation Engineering  |                                  |   |                    |  |
| Prerequisite credits   |                         |                                  |   |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses                 |                         |                                  |   |                    |  |
| Overlap course codes<br>As per proposed Course Numbers<br>Text Book<br>( Max. 2) | Title                   | Water Resources Engineering      |   |                    |  |
|  | Author                  | Linsley R. K. and Franzini J. B. |   |                    |  |
|  | Publisher               | McGrawHill Book Co., New York    |   |                    |  |
|  | Edition                 | 1964.                            |   |                    |  |
|  | Title                   | Water Resources Engineering      |   |                    |  |
|  | Author                  | Ralph A. Wurbs, Wesley P Jamer   |   |                    |  |
|  | Publisher               | Prentice Hall                    |   |                    |  |
|  | Edition                 | 2002                             |   |                    |  |
|  | Reference Books         | Title                            | Elements of Water Resources Engineering |                    |  |
|  |                         | Author                           | Duggal K N & Soni J P,                  |                    |  |
| Publisher  |                         | New Age International Publishers |   |                    |  |
| Edition  |                         |                                  |   |                    |  |
| Title  |                         |                                  |   |                    |  |
| Author   |                         |                                  |   |                    |  |
| Publisher  |                         |                                  |   |                    |  |
| Edition  |                         |                                  |   |                    |  |
| Title  |                         |                                  |   |                    |  |
| Author   |                         |                                  |   |                    |  |
| Publisher  |                         |                                  |   |                    |  |
| Edition  |                         |                                  |   |                    |  |
| Title  |                         |                                  |   |                    |  |
| Author   |                         |                                  |   |                    |  |
| Publisher  |                         |                                  |   |                    |  |
| Edition  |                         |                                  |   |                    |  |
|  | Title                   |                                  |   |                    |  |
|  | Author                  |                                  |   |                    |  |
|  | Publisher               |                                  |   |                    |  |
|  | Edition                 |                                  |   |                    |  |

|            |   |  |
|------------|---|--|
|            | Title   |  |
|            | Author  |  |
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <p>Scope of water resources engineering</p> <p>Planning for water resources development : objective, multipurpose projects, different purposes, items to be considered in planning for different purposes, hydrologic appraisal of water resources.</p> <p>Project formulation, project investigation and planning reconnaissance, detailed investigations and final planning, economics of water resources planning.</p> <p>Principles of engineering economics, equivalence of kind time, tangible and intangible values.</p> <p>Mathematics of economic analysis, discounting factors and different discounting techniques.</p> <p>Economic planning for flood control, domestic and industrial water supply, irrigation and hydroelectric power; cost allocation in multipurpose projects.</p> <p>Optimization of water resources development, graphic optimization techniques for single purpose and dual purpose projects. Analytical optimization techniques. Applications of linear and dynamic programming techniques.</p> |  |
| Course No. | CEL428  |  |

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### Course Content Proforma

**Department: Civil Engineering**

|  |                |   |                        |                           |
|--|----------------|---|------------------------|---------------------------|
| <b>Course No.:</b>   | <b>CEL412</b>  | <b>Open Course (Y/N)</b>  | <b>HM Course (Y/N)</b> | <b>Discontinued (Y/N)</b> |
| <b>Course Title: Spatial Analysis for Resource Management</b>                    |                |   |                        |                           |
| <b>Course Coordinator: Dr. Y.B.Katpatal</b>                                      |                |   |                        |                           |
| <b>Slot in which offered, if not offered write N</b>                             | <b>Odd</b>     |   | <b>Even</b>            |                           |
|  |                |   | <b>C</b>               |                           |
| <b>Structure</b>   | <b>Lecture</b> | <b>Tutorial</b>   | <b>Practical</b>       | <b>Credits</b>            |
|  | <b>3</b>       | <b>0</b>  | <b>2</b>               | <b>8</b>                  |
| <b>Prerequisite Course Codes As per proposed Course numbers</b>                  |                |   |                        |                           |
| <b>Prerequisite Credits</b>  |                |   |                        |                           |
| <b>Equivalent Course Course Codes. As per proposed Courses &amp; old courses</b> |                |   |                        |                           |
| <b>Overlap Course Codes As per proposed Course numbers</b>                       |                |   |                        |                           |
| <b>Text Book (Max. 2)</b>  | <b>Title</b>   | <b>Concepts and techniqes of Geographic Infromation Systems</b>   |                        |                           |
|  | Author         | C.P LO Albert KW Yeung  |                        |                           |
|  | Publisher      | Pritince Hall of India  |                        |                           |
|  | Edition        | 2002  |                        |                           |
|  | <b>Title</b>   | <b>Text Book on Remote Sensing</b>                                |                        |                           |
|  | Author         | C.S. Agrawal & P K Garg   |                        |                           |
|  | Publisher      | Wheeler   |                        |                           |
|  | Edition        | First   |                        |                           |
| <b>Reference Books</b>   | <b>Title</b>   | Geographic Information Systems and Science                        |                        |                           |
|  | Author         | Paul A. Longley, M. Goodchild, David Maguire, David Rhind         |                        |                           |
|  | Publisher      | Wiley   |                        |                           |
|  | Edition        | First   |                        |                           |
|  | <b>Title</b>   | Keith C. Clerk, Bradely O Parks, Michel P Crane                   |                        |                           |
|  | Author         | Geographic Informaiton System and Enviornment Modeling            |                        |                           |
|  | Publisher      | Pritince Hall of India  |                        |                           |
|  | Edition        | 2002  |                        |                           |
|  | <b>Title</b>   | Remote Sensing of the Environment ..an Earth Resource Perspective |                        |                           |
|  | Author         | John R Jensen   |                        |                           |
|  | Publisher      | Pearson Education   |                        |                           |
|  | Edition        | 2006  |                        |                           |
|  |                |   |                        |                           |
|  |                |   |                        |                           |

|                   |   |
|-------------------|---|
| <b>Content</b>    | <p>Fundamentals of Geoinformatics: raster and Vector Data, Resolutions of RS data, Thermal and Radar Sensing, spatial and non spatial information, attribute data collection, data formats, data conversions. RS as a technology for data extraction technique, multithematic data extraction using multispectral sensors, thematic map generation.</p> <p>Overlay analyses, Buffer analyses, Query shell. Spatial analysis, Modeling of spatial data, Network analysis, digital terrain elevation models, Customization and Decision Support Systems.</p> <p>Applications of Geoinformatics for spatial management of resources: Run-off estimations, infiltration characteristics, groundwater potential and recharge characteristics, Watershed management, watershed prioritization, Sediment yield estimation, reservoir capacity studies, Spatial analyses for Environment Impact assessment, Monitoring and feedback, Natural indices, Concept of E-Governance using Geoinformatics. Integrated applications using various technologies within Geoinformatics; methods and approach. Real time and temporal analysis using Geoinformatics.</p> <p>Multidisciplinary applications of Geoinformatics; integration of various segments. Geoinformatics for resources management and utilities management.</p> |
| <b>Practical</b>  | <p>Spatial Digital Data and its Formats<br/> Digital Image analysis and Classification<br/> Vector Data generation, topology building and attribution<br/> Overlay, Buffer and Network analysis<br/> Models for Resource analysis</p>   |
| <b>Course No.</b> |   |

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### Course Content Proforma

**Department :** Civil Engineering

|  |   |   |                 |                    |  |
|--|---|---|-----------------|--------------------|--|
| Course No.   | CEL514  | Open Course (Y/N)                           | HM Course (Y/N) | Discontinued (Y/N) |  |
| Course Title   | Applied Surface Hydrology                                       |   |                 |                    |  |
| Course Coordinator   | Dr. A. D. Ghare   |   |                 |                    |  |
| Slot in which offered. If not offered write N                    | Odd   |   | Even            |                    |  |
|  |   |   | G               |                    |  |
| Structure  | Lecture   | Tutorial                                    | Practical       | Credits            |  |
|  | 2   | 1   | 0               | 6                  |  |
| Prerequisite Course Codes As per proposed Course Numbers         |   |   |                 |                    |  |
| Prerequisite credits   |   |   |                 |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses |   |   |                 |                    |  |
| Overlap course codes As per proposed Course Numbers              |   |   |                 |                    |  |
| Text Book<br>( Max. 2)   | Title   | Applied Hydrology                           |                 |                    |  |
|  | Author  | Chow Ven Te, Maidment R David, Mays W Larry |                 |                    |  |
|  | Publisher   | McGraw-Hill New Delhi                       |                 |                    |  |
|  | Edition   | 1998  |                 |                    |  |
|  | Title   | Engineering Hydrology,                      |                 |                    |  |
|  | Author  | Linsley , Kohler & Paulhus,                 |                 |                    |  |
|  | Publisher   | Mc Graw Hill                                |                 |                    |  |
|  | Edition   |   |                 |                    |  |
| Reference Books  | Title   | Engineering Hydrology                       |                 |                    |  |
|  | Author  | Subramanya K                                |                 |                    |  |
|  | Publisher   | Tata McGraw-Hill, New Delhi                 |                 |                    |  |
|  | Edition   | 1996  |                 |                    |  |
|  | Title   | A Text Book of Hydrology                    |                 |                    |  |
|  | Author  | Dr. P. Jayarami Reddi                       |                 |                    |  |
|  | Publisher   | Laxmi Publications, New Delhi               |                 |                    |  |
|  | Edition   |   |                 |                    |  |
|  | Title   |   |                 |                    |  |
|  | Author  |   |                 |                    |  |
|  | Publisher   |   |                 |                    |  |
|  | Edition   |   |                 |                    |  |
|  | Title   |   |                 |                    |  |
|  | Title   |   |                 |                    |  |
| Author   |   |   |                 |                    |  |
| Publisher  |   |   |                 |                    |  |
| Edition  |   |   |                 |                    |  |
| Content  | Rainfall measurement, recording and non-recording gauges, radar |   |                 |                    |  |

|            |   |
|------------|---|
|            | <p>measurement, raingauge network.</p> <p>Space-time characteristics – double mass curve. Station-year method, interpolation of rainfall records, average rainfall depth, area duration analysis.</p> <p>Frequency analysis – Area depth relationship, seasonal variation, calculated risk, frequency for storm transportation, probable maximum precipitation.</p> <p>Evapotranspiration, evaporation – nature of process from free water surfaces, factors affecting measurement, estimation and reduction from soil surfaces. Transpiration – Nature of process, factors affecting, determination, evapotranspiration – methods of estimation, equations.</p> <p>Infiltration – factors affecting measurement, infiltrometers and hydrograph analysis, infiltration in computation of runoff for small and large watersheds, infiltration indices, Runoff : factors affecting rainfall – runoff relationship.</p> <p>Hydrographs ; features, components, base flow separation, Unit hydrograph theory, analysis, application and modification, instantaneous unit hydrograph and deptual models. Variability of runoff – flow duration and flow mass curves.</p> <p>Floods : Characteristics; elevation, discharges, volume and duration flood formulae, discharge – frequency and stage – frequency curves, maximum probable flood, design flood and its estimation.</p> <p>Statistical Analysis : Importance in hydrology, frequency probability and statistical distribution, recurrence, interval probability paper, reliability of analysis; applications to rain fall, stream flow, flood and drought studies.</p> |
| Course No. | CEL514  |

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|  |        |  |                 |                    |
|--|--------|--|-----------------|--------------------|
| Course No.   | CEP503 | Open course (Y/N)                      | HM Course (Y/N) | Discontinued (Y/N) |
| Course Title   |        | Water Resources Engineering Laboratory |                 |                    |
| Course Coordinator   |        | Prof A D Vasudeo                       |                 |                    |
| Slot in which offered. If not offered write N                    |        | Odd                                    |                 | Even               |
|  |        | E                                      |                 |                    |
| Structure  |        | Lecture                                | Tutorial        | Practical          |
|  |        | 0                                      | 0               | 4                  |
| Prerequisite Course Codes As per proposed Course Numbers         |        |  |                 |                    |
| Prerequisite credits   |        |  |                 |                    |
| Equivalent Course Codes. As per proposed courses and old courses |        |  |                 |                    |
| Overlap course codes As per proposed Course Numbers              |        |  |                 |                    |
| Text Book<br>( Max. 2)   |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
| Reference Books  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
|  |        | Publisher                              |                 |                    |
|  |        | Edition                                |                 |                    |
|  |        | Title                                  |                 |                    |
|  |        | Author                                 |                 |                    |
| Publisher  |        |  |                 |                    |

|            |   |  |
|------------|---|--|
|            | Edition   |  |
| Content    | List of experiments : <ol style="list-style-type: none"> <li>1. Hydrostatic forces on immersed body.</li> <li>2. Determination of viscosity of fluid.</li> <li>3. Pumps in parallel.</li> <li>4. Pumps in series.</li> <li>5. Forced and Free vortices.</li> <li>6. Flow visualization by laminar flow table.</li> <li>7. Study of sediment transport mechanism.</li> <li>8. Experiment on Osborne Reynolds apparatus.</li> <li>9. Energy losses in pipes.</li> <li>10. Calculation of cavitation force.</li> </ol> |  |
| Course No. | CEP503  |  |

Head of The Department of Civil Engineering



|            |  |  |
|------------|--|--|
|            | Publisher  |  |
|            | Edition  |  |
| Content    | <p>Steady flow through closed conduits : Empirical formulae for frictional loss for flow through pipes, Minor losses, Pipes connected in series, parallel, Flow through a by pass, Syphon, Three reservoir case, Transmission of power, pipe network – Hardy Cross method, Loss of head in a pipe with varying discharge, Loss of head in non circular conduits, Flow through nozzle fitted to pipe, Flow in pipe bends, Loss of head in tapering pipes, Time of discharge from one reservoir to another, Pipeline with a pump or a turbine</p> <p>Unsteady flow in closed conduits : Unsteady Bernoulli's equation, Mass oscillations in U-tube, time of establishment of flow in pipeline</p> <p>Water hammer phenomenon : Fundamental differential equations, rigid column theory, elastic wave in single and complex conduits, calculation of water hammer pressure, Allievi's theory and use of allievi's charts, effect of friction, method of characteristics, Water hammer pressures in pumping systems, analysis of flow in surge tank systems. Calculation of maximum surges, study of stability problem, Thoma's criteria</p> |  |
| Course No. | CEL429   |  |

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## Course Content Proforma

**Department :** Civil Engineering

|  |                    |   |                 |                    |  |
|--|--------------------|---|-----------------|--------------------|--|
| Course No.   | CEL419             | Open Course (Y/N)   | HM Course (Y/N) | Discontinued (Y/N) |  |
| Course Title   | River Engineering  |   |                 |                    |  |
| Course Coordinator   | Dr A D Ghare       |   |                 |                    |  |
| Slot in which offered. If not offered write N                    | Odd                |   | Even            |                    |  |
|  |                    |   | G               |                    |  |
| Structure  | Lecture            | Tutorial  | Practical       | Credits            |  |
|  | 3                  | 0   | 0               | 6                  |  |
| Prerequisite Course Codes As per proposed Course Numbers         | Fluid Mechanics II |   |                 |                    |  |
| Prerequisite credits   |                    |   |                 |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses |                    |   |                 |                    |  |
| Overlap course codes As per proposed Course Numbers              |                    |   |                 |                    |  |
| Text Book<br>( Max. 2)   | Title              | Mechanics of Sediment Transportation and Alluvial Stream Problems |                 |                    |  |
|  | Author             | Garde R J and Ranga Raju K G                                      |                 |                    |  |
|  | Publisher          | Wiley Eastern Ltd.  |                 |                    |  |
|  | Edition            | 1985  |                 |                    |  |
|  | Title              | Sediment Transport- Theory and Practice                           |                 |                    |  |
|  | Author             | Yang C.T.   |                 |                    |  |
|  | Publisher          | The McGraw Hill Companies Inc.                                    |                 |                    |  |
|  | Edition            | 1996  |                 |                    |  |
| Reference Books  | Title              | Fluvial Processes in River Engineering                            |                 |                    |  |
|  | Author             | Chang H.H.  |                 |                    |  |
|  | Publisher          | John Wiley  |                 |                    |  |
|  | Edition            | 1988  |                 |                    |  |
|  | Title              | Sediment Transport Technology                                     |                 |                    |  |
|  | Author             | Simons D.B. and Senturk F.  |                 |                    |  |
|  | Publisher          | Water Resources Publications, Fort Collins, Colorado              |                 |                    |  |
|  | Edition            | 1977  |                 |                    |  |
|  | Title              |   |                 |                    |  |
|  | Author             |   |                 |                    |  |
|  | Publisher          |   |                 |                    |  |
|  | Edition            |   |                 |                    |  |
|  | Title              |   |                 |                    |  |
|  | Author             |   |                 |                    |  |
|  | Publisher          |   |                 |                    |  |
|  | Edition            |   |                 |                    |  |
| Title  |                    |   |                 |                    |  |
| Author   |                    |   |                 |                    |  |

|            |   |  |
|------------|---|--|
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <p>Origin and properties of sediments : Nature of sediment problems , origin and formation of sediments , properties of sediments , incipient motion of sediment particles , tractive force approach, cohesive materials.</p> <p>Regimes of flow : Description of regimes of flow , ripple , dune , antidune , prediction of regimes of flow.</p> <p>Resistance to flow &amp; velocity distribution in alluvial streams : velocity distribution in turbulent flow over rough boundaries, resistance and velocity distribution in alluvial streams.</p> <p>Bed load transport &amp; saltation : Bed load equations, bed load equations based upon dimensional considerations and semi-theoretical equations, general comments on bed load equations , saltation..</p> <p>Suspended load transport : Mechanism of suspension, equation of diffusion , sediment distribution equation , relations for suspended load, wash load , transport of suspended sediment.</p> <p>Total load transport : sediment samplers design of canals carrying sediment laden water<br/>Types of sediment samplers<br/>Design of channels carrying sediment laden water<br/>Sediment transport through pipes</p> |  |
| Course No. | CEL419  |  |

Head of The Department of Civil Engineering

### Course Content Proforma

**Department :** Civil Engineering

|  |        |                            |                 |   |         |  |  |
|--|--------|----------------------------|-----------------|---|---------|--|--|
| Course No.   | CEL414 | Open Course (Y/N)          | HM Course (Y/N) | Discontinued (Y/N)                            |         |  |  |
| Course Title   |        | Water Distribution Systems |                 |   |         |  |  |
| Course Coordinator   |        |                            |                 |   |         |  |  |
| Slot in which offered. If not offered write N                    |        | Odd                        |                 | Even  |         |  |  |
|  |        | D                          |                 |   |         |  |  |
| Structure  |        | Lecture                    | Tutorial        | Practical                                     | Credits |  |  |
|  |        | 03                         | 01              | 00  | 08      |  |  |
| Prerequisite Course Codes As per proposed Course Numbers         |        |                            |                 |   |         |  |  |
| Prerequisite credits   |        |                            |                 |   |         |  |  |
| Equivalent Course Codes. As per proposed courses and old courses |        |                            |                 |   |         |  |  |
| Overlap course codes As per proposed Course Numbers              |        |                            |                 |   |         |  |  |
| Text Book<br>( Max. 2)   |        | Title                      |                 | Analysis of water distribution Networks       |         |  |  |
|  |        | Author                     |                 | Bhave , P.R. and Gupta R.                     |         |  |  |
|  |        | Publisher                  |                 | Nawas Publishing Co, New Delhi.               |         |  |  |
|  |        | Edition                    |                 |   |         |  |  |
|  |        | Title                      |                 | Optimal Design of Water Distribution Networks |         |  |  |
|  |        | Author                     |                 | Bhave P.R.                                    |         |  |  |
|  |        | Publisher                  |                 | Nawas Publishing Co, New Delhi.               |         |  |  |
|  |        | Edition                    |                 |   |         |  |  |
|  |        | Reference Books            |                 | Title   |         | Analysis of flow in pipe networks        |  |
|  |        |                            |                 | Author  |         | Jeppson R.W.                             |  |
|  |        |                            |                 | Publisher                                     |         | Ann Arbon Science Aun Arbox Michigan USA |  |
|  |        |                            |                 | Edition                                       |         |  |  |
|  |        |                            |                 | Title   |         | Analysis of water distribution System    |  |
|  |        |                            |                 | Author  |         | Walksi T-M                               |  |
| Publisher  |        |                            |                 | Van Nostand Reinheld G, New York USA          |         |  |  |
| Edition  |        |                            |                 | 1984  |         |  |  |
| Title  |        |                            |                 | Manual on Water Supply and Treatment          |         |  |  |
| Author   |        |                            |                 | CPHEEO  |         |  |  |
| Publisher  |        |                            |                 | Ministry of Urban Development G01             |         |  |  |
| Edition  |        |                            |                 |   |         |  |  |
| Title  |        |                            |                 |   |         |  |  |
| Author   |        |                            |                 |   |         |  |  |
| Title  |        |                            |                 |   |         |  |  |
| Author   |        |                            |                 |   |         |  |  |

|            |  |  |
|------------|--|--|
|            | Publisher  |  |
|            | Edition  |  |
| Content    | <ol style="list-style-type: none"> <li>1. General Hydraulic Principles, Head loss formulae- Darcy-Waisbach formula, Hazen – Williams formula, Modified Hazee- Williams formula, Series and Parallel connection of Pipes, Equivalent Pipes, Analysis of branched Water Distribution Networks.</li> <li>2. Formulation of Equations for looped Water Distribution Networks, Analysis of flow in looped networks using Hardy Cross, Newton-Raphson and Linear Theory method, Introduction of Gradient method and other methods of analysis.</li> <li>3. Reservoirs, Pumps and Valves (check valve, flow control valve and pressure reduces valve) in Water distribution systems. Flow dependent analysis of multi-reservoir systems, Introduction to head-dependent analysis.</li> <li>4. Node flow analysis of water distribution networks:- Node head – discharge relationships, Direct and Indirect methods, Application of NFA technique to serial networks.</li> <li>5. Optimal and Economical diameter of pumping main Design of pumping main considering rising main diameter as continuous as well as discrete variable. Water hammer consideration.</li> <li>6. Design of water distribution networks using Critical path method, Formulation of optimization model, Application of Cost-head loss ratio method and linear programming technique to optimal design of branched networks.</li> </ol> <p>Determining number of branching configuration for a looped network, Use of path concept and minimum spanning tree concept, Application of critical path method for design of looped networks.</p> |  |
| Course No. | CEL414   |  |

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|  |                        |   |                    |                    |  |
|--|------------------------|---|--------------------|--------------------|--|
| Course No.   | CEL430                 | Open course<br>(Y/N)  | HM Course<br>(Y/N) | Discontinued (Y/N) |  |
| Course Title   | Hydraulic Structures I |   |                    |                    |  |
| Course Coordinator   | Dr A D Ghare           |   |                    |                    |  |
| Slot in which offered. If not offered write N                          | Odd                    |   | Even               |                    |  |
| Structure  | Lecture                | Tutorial  | Practical          | Credits            |  |
|  | 2                      | 1   | 0                  | 6                  |  |
| Prerequisite Course Codes<br>As per proposed Course<br>Numbers         | Irrigation Engineering |   |                    |                    |  |
| Prerequisite credits   |                        |   |                    |                    |  |
| Equivalent Course Codes. As<br>per proposed courses and old<br>courses |                        |   |                    |                    |  |
| Overlap course codes<br>As per proposed Course<br>Numbers              |                        |   |                    |                    |  |
| Text Book<br>( Max. 2)   | Title                  | Irrigation and Water Power Engineering                                |                    |                    |  |
|  | Author                 | Punmia B.C. and Pande B.B. Lal  |                    |                    |  |
|  | Publisher              | Laxmi Publications Pvt. Ltd   |                    |                    |  |
|  | Edition                | 2003  |                    |                    |  |
|  | Title                  | Irrigation Engineering and Hydraulic Structures                       |                    |                    |  |
|  | Author                 | Garg Santosh Kumar  |                    |                    |  |
|  | Publisher              | Khanna Publishers, New Delhi  |                    |                    |  |
|  | Edition                | 2004  |                    |                    |  |
| Reference Books  | Title                  | Design of Small Dams  |                    |                    |  |
|  | Author                 |   |                    |                    |  |
|  | Publisher              | U.S. Bureau Reclamation, Oxford and IBH<br>Publication Co., New Delhi |                    |                    |  |
|  | Edition                | 1960  |                    |                    |  |
|  | Title                  |   |                    |                    |  |
|  | Author                 |   |                    |                    |  |
|  | Publisher              |   |                    |                    |  |
|  | Edition                |   |                    |                    |  |
|  | Title                  |   |                    |                    |  |
|  | Author                 |   |                    |                    |  |
|  | Publisher              |   |                    |                    |  |
|  | Edition                |   |                    |                    |  |
|  | Title                  |   |                    |                    |  |
|  | Author                 |   |                    |                    |  |
| Publisher  |                        |   |                    |                    |  |

|            | Edition   |  |
|------------|---|--|
| Content    | Spillways : Necessity, components and classification, Estimation of spillway design flood<br>Design considerations of overflow/ ogee spillways: Design as per IS, Effect of submergence by tail water, Effect of silting upstream of spillway, Discharge coefficients versus crest pressures<br>Design considerations of side channel spillways and chute spillways, Effect of contraction<br>Design considerations of shaft spillways<br>Design principles for culverts and small bridges, causeways and box culverts<br>River behaviour, control and training, design of guide banks<br>Design of hydraulic jump type energy dissipator- stilling basin as per IS |  |
| Course No. | CEL430  |  |

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## Course Content Proforma

Department : Civil Engineering

|  |                        |                                   |                 |                    |
|--|------------------------|-----------------------------------|-----------------|--------------------|
| Course No.   | CEL420                 | Open Course (Y/N)                 | HM Course (Y/N) | Discontinued (Y/N) |
| Course Title   | Earthen Dams           |                                   |                 |                    |
| Course Coordinator   | Prof. A. D. Vasudeo    |                                   |                 |                    |
| Slot in which offered. If not offered write N                    | Odd                    |                                   | Even            |                    |
| Structure  | Lecture                | Tutorial                          | Practical       | Credits            |
|  | 3                      | 1                                 | 0               | 8                  |
| Prerequisite Course Codes As per proposed Course Numbers         | Irrigation Engineering |                                   |                 |                    |
| Prerequisite credits   |                        |                                   |                 |                    |
| Equivalent Course Codes. As per proposed courses and old courses |                        |                                   |                 |                    |
| Overlap course codes As per proposed Course Numbers              |                        |                                   |                 |                    |
| Text Book<br>( Max. 2)   | Title                  | Earth and Rock Fill dams          |                 |                    |
|  | Author                 | Sower & Sally                     |                 |                    |
|  | Publisher              | Asia publishing house             |                 |                    |
|  | Edition                |                                   |                 |                    |
|  | Title                  | Engineering for Dams              |                 |                    |
|  | Author                 | Creager, Justine, Hinds           |                 |                    |
|  | Publisher              | John Wiley & Sons                 |                 |                    |
|  | Edition                |                                   |                 |                    |
| Reference Books  | Title                  | U. S. B. R. Design of Small Dams, |                 |                    |
|  | Author                 |                                   |                 |                    |
|  | Publisher              | IBH Publisher                     |                 |                    |
|  | Edition                |                                   |                 |                    |
|  | Title                  |                                   |                 |                    |
|  | Author                 |                                   |                 |                    |
|  | Publisher              |                                   |                 |                    |
|  | Edition                |                                   |                 |                    |
|  | Title                  |                                   |                 |                    |
|  | Author                 |                                   |                 |                    |
|  | Publisher              |                                   |                 |                    |
|  | Edition                |                                   |                 |                    |
|  | Title                  |                                   |                 |                    |
|  | Author                 |                                   |                 |                    |
|  | Publisher              |                                   |                 |                    |
|  | Edition                |                                   |                 |                    |
| s  | Title                  |                                   |                 |                    |
|  | Author                 |                                   |                 |                    |
|  | Publisher              |                                   |                 |                    |
|  | Edition                |                                   |                 |                    |
|  | Title                  |                                   |                 |                    |
|  | Publisher              |                                   |                 |                    |

|            |   |  |
|------------|---|--|
|            | Edition   |  |
| Content    | <p>Introduction, types and advantages of embankment dams</p> <p>Factors affecting the designs of Embankment Dams, Safety criteria.</p> <p>Theoretical Analysis of seepage through embankment and its application. Control of seepage through embankment dams.</p> <p>Stability analysis including seismic stability.</p> <p>Construction aspects.</p> <p>Instrumentation in dams. Typical problems and their solutions in embankment dams. Rockfill dams.</p> |  |
| Course No. | CEL420  |  |

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### Course Content Proforma

**Department :** Civil Engineering

|  |                          |  |                 |                    |  |
|--|--------------------------|--|-----------------|--------------------|--|
| Course No.   | CEL515                   | Open Course (Y/N)                          | HM Course (Y/N) | Discontinued (Y/N) |  |
| Course Title   | Advanced Fluid Mechanics |  |                 |                    |  |
| Course Coordinator   | Dr A D Ghare             |  |                 |                    |  |
| Slot in which offered. If not offered write N                    | Odd                      |  | Even            |                    |  |
|  | N                        |  | N               |                    |  |
| Structure  | Lecture                  | Tutorial                                   | Practical       | Credits            |  |
|  | 3                        | 0  | 0               | 6                  |  |
| Prerequisite Course Codes As per proposed Course Numbers         | Fluid Mechanics          |  |                 |                    |  |
| Prerequisite credits   |                          |  |                 |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses |                          |  |                 |                    |  |
| Overlap course codes As per proposed Course Numbers              |                          |  |                 |                    |  |
| Text Book<br>( Max. 2)   | Title                    | Foundations of Fluid Mechanics             |                 |                    |  |
|  | Author                   | Yuan S. W.                                 |                 |                    |  |
|  | Publisher                | Prentice – Hall India Pvt. Ltd., New Delhi |                 |                    |  |
|  | Edition                  | 1969                                       |                 |                    |  |
|  | Title                    | Engineering Fluid Mechanics                |                 |                    |  |
|  | Author                   | Narasimhan S.                              |                 |                    |  |
|  | Publisher                | Orient Longman Ltd                         |                 |                    |  |
|  | Edition                  | 1975                                       |                 |                    |  |
| Reference Books  | Title                    | Tubulent Flow                              |                 |                    |  |
|  | Author                   | Garde R. J.                                |                 |                    |  |
|  | Publisher                | Wiley Eastern Ltd.                         |                 |                    |  |
|  | Edition                  | 1994                                       |                 |                    |  |
|  | Title                    |  |                 |                    |  |
|  | Author                   |  |                 |                    |  |
|  | Publisher                |  |                 |                    |  |
|  | Edition                  |  |                 |                    |  |
|  | Title                    |  |                 |                    |  |
|  | Author                   |  |                 |                    |  |
|  | Publisher                |  |                 |                    |  |
|  | Edition                  |  |                 |                    |  |
|  | Title                    |  |                 |                    |  |
|  | Author                   |  |                 |                    |  |
|  | Publisher                |  |                 |                    |  |
|  | Edition                  |  |                 |                    |  |
| Title  |                          |  |                 |                    |  |
| Author   |                          |  |                 |                    |  |

|            |   |  |
|------------|---|--|
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <p>Principles of ideal fluid flow : fundamental equations, velocity potential and stream functions for two dimensional flow patterns, uniform flow, sources, sink and vortex flow, doublet, solution of physical problems, free stream lines.</p> <p>Flow of real fluids, Navier-Stoke's equations, some solutions of practical problem, boundary layer theory; boundary layer equations for two dimensional flows; some methods for their solutions, turbulent boundary layers, separation, boundary layer control.</p> <p>Transition from laminar to turbulent flow; problem of stability.</p> <p>Turbulent flow; Reynolds equations; theories of turbulence, free turbulent flow; turbulent flow in pipes and open channels.</p> |  |
| Course No. | CEL515  |  |

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### Course Content Proforma

**Department :** Civil Engineering

|  |                      |   |                 |                    |
|--|----------------------|---|-----------------|--------------------|
| Course No.   | CEL516               | Open Course (Y/N)   | HM Course (Y/N) | Discontinued (Y/N) |
| Course Title   | Modelling Techniques |   |                 |                    |
| Course Coordinator   | Dr A D Ghare         |   |                 |                    |
| Slot in which offered. If not offered write N                    | Odd                  |   | Even            |                    |
|  | N                    |   | N               |                    |
| Structure  | Lecture              | Tutorial  | Practical       | Credits            |
|  | 3                    | 0   | 0               | 6                  |
| Prerequisite Course Codes As per proposed Course Numbers         | Fluid Mechanics      |   |                 |                    |
| Prerequisite credits   |                      |   |                 |                    |
| Equivalent Course Codes. As per proposed courses and old courses |                      |   |                 |                    |
| Overlap course codes As per proposed Course Numbers              |                      |   |                 |                    |
| Text Book<br>( Max. 2)   | Title                | Theory of Hydraulic Models  |                 |                    |
|  | Author               | Yalin M S   |                 |                    |
|  | Publisher            | Macmillan, London   |                 |                    |
|  | Edition              | 1971  |                 |                    |
|  | Title                | Hydraulic Modeling  |                 |                    |
|  | Author               | Sharp J J   |                 |                    |
|  | Publisher            | Butterworth Group   |                 |                    |
|  | Edition              | 1981  |                 |                    |
| Reference Books  | Title                | Models in Hydraulic Engineering: Physical Principals and Design Applications, Vol 4 |                 |                    |
|  | Author               | Novok P and Cabelka J   |                 |                    |
|  | Publisher            | Pitman Advanced Publishing  |                 |                    |
|  | Edition              |   |                 |                    |
|  | Title                |   |                 |                    |
|  | Author               |   |                 |                    |
|  | Publisher            |   |                 |                    |
|  | Edition              |   |                 |                    |
|  | Title                |   |                 |                    |
|  | Author               |   |                 |                    |
|  | Publisher            |   |                 |                    |
|  | Edition              |   |                 |                    |
|  | Title                |   |                 |                    |
|  | Author               |   |                 |                    |
|  | Publisher            |   |                 |                    |
|  | Edition              |   |                 |                    |
| Title  |                      |   |                 |                    |
| Author   |                      |   |                 |                    |

|            |   |  |
|------------|---|--|
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <p>Purpose and utility of hydraulic models; principles of dimensional analysis, Raleigh method, Buckingham's pi method, non-dimensional parameters and their application to practical problems, principles of hydraulic similitude, different types of similarity and model laws, scale effect. Types of hydraulic models such as distorted and undistorted, movable bed models, effect of earth's rotation, models for spillways, energy dissipators and flood control. Principles of design and construction, interpretation of model results, mathematical modelling and regression techniques</p> <p>Finite Difference Method: explicit &amp; implicit schemes, application to water resources. Finite element method: domain selection, introduction to problems solving techniques</p> <p>Advanced techniques in water resources: Introduction to Fuzzy Logic, Introduction to Artificial neural network, Introduction to genetic algorithm</p> |  |
| Course No. | CEL516  |  |

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## Course Content Proforma

**Department :** Civil Engineering

|  |                         |   |  |                       |  |
|--|-------------------------|---|--|-----------------------|--|
| Course No.   | CEL517                  | Open Course<br>(Y/N)                            | HM Course<br>(Y/N)   | Discontinued<br>(Y/N) |  |
| Course Title   | Hydraulic Structures II |   |  |                       |  |
| Course Coordinator   | Dr A D Ghare            |   |  |                       |  |
| Slot in which offered. If not offered write N                    | Odd                     |   | Even   |                       |  |
|  | N                       |   | N  |                       |  |
| Structure  | Lecture                 | Tutorial  | Practical  | Credits               |  |
|  | 2                       | 1   | 0  | 6                     |  |
| Prerequisite Course Codes<br>As per proposed Course Numbers      | Hydraulic Structures I  |   |  |                       |  |
| Prerequisite credits   |                         |   |  |                       |  |
| Equivalent Course Codes. As per proposed courses and old courses |                         |   |  |                       |  |
| Overlap course codes<br>As per proposed Course Numbers           |                         |   |  |                       |  |
| Text Book<br>(Max. 2)  | Title                   | Irrigation and Water Power Engineering          |  |                       |  |
|  | Author                  | Punmia B.C. and Pande B.B. Lal                  |  |                       |  |
|  | Publisher               | Laxmi Publications Pvt. Ltd                     |  |                       |  |
|  | Edition                 | 2003  |  |                       |  |
|  | Title                   | Irrigation Engineering and Hydraulic Structures |  |                       |  |
|  | Author                  | Garg Santosh Kumar                              |  |                       |  |
|  | Publisher               | Khanna Publishers, New Delhi                    |  |                       |  |
|  | Edition                 | 2004  |  |                       |  |
|  | Reference Books         | Title   | Design of Small Dams   |                       |  |
|  |                         | Author  |  |                       |  |
|  |                         | Publisher                                       | U.S. Bureau Reclamation, Oxford and IBH Publication Co., New Delhi |                       |  |
|  |                         | Edition   | 1960   |                       |  |
|  |                         | Title   |  |                       |  |
|  |                         | Author  |  |                       |  |
| Publisher  |                         |   |  |                       |  |
| Edition  |                         |   |  |                       |  |
| Title  |                         |   |  |                       |  |
| Author   |                         |   |  |                       |  |
| Publisher  |                         |   |  |                       |  |
| Edition  |                         |   |  |                       |  |
| Title  |                         |   |  |                       |  |
| Author   |                         |   |  |                       |  |
| Publisher  |                         |   |  |                       |  |
| Edition  |                         |   |  |                       |  |
| Title  |                         |   |  |                       |  |
| Author   |                         |   |  |                       |  |
| Publisher  |                         |   |  |                       |  |
| Edition  |                         |   |  |                       |  |
| Title  |                         |   |  |                       |  |

|            |  |  |
|------------|--|--|
|            | Author   |  |
|            | Publisher  |  |
|            | Edition  |  |
| Content    | <p>Design of weirs and barrages over permeable foundations : Causes of failure, Bligh's and Lane's creep theory, Khosla's theory and method of independent variables, standard profiles, corrections, exit gradient, plotting of HGL, Design of d/s and u/s protection works, length of pucca concrete floor</p> <p>Canal falls : Types and design principles</p> <p>Canal regulation works : Alignment of offtaking channels, Distributaries, head regulator, cross regulator and their design, weir type and regulator type escapes, metering flumes, types of modules, Kennedy's gauge outlet</p> <p>Design considerations for cross drainage works : Fluming the canal, Hind's method for design of transition, Design of pucca canal trough</p> <p>Hydraulics of outlet works : Sluiceways, river intakes, simple submerged intakes, trash racks</p> <p>Preliminary concepts of design of stepped spillways and labyrinth weirs</p> |  |
| Course No. | CEL517   |  |

Head of The Department of Civil Engineering

### Course Content Proforma

**Department :** Civil Engineering

|  |                             |   |                 |                    |
|--|-----------------------------|---|-----------------|--------------------|
| Course No.   | CEL518                      | Open course (Y/N)   | HM Course (Y/N) | Discontinued (Y/N) |
| Course Title   | Coastal Engineering         |   |                 |                    |
| Course Coordinator   | Prof. A. D. Vasudeo         |   |                 |                    |
| Slot in which offered. If not offered write N                    | Odd                         |   | Even            |                    |
|  | N                           |   | N               |                    |
| Structure  | Lecture                     | Tutorial  | Practical       | Credits            |
|  | 3                           | 0   | 0               | 6                  |
| Prerequisite Course Codes As per proposed Course Numbers         | Water Resources Engineering |   |                 |                    |
| Prerequisite credits   |                             |   |                 |                    |
| Equivalent Course Codes. As per proposed courses and old courses |                             |   |                 |                    |
| Overlap course codes As per proposed Course Numbers              |                             |   |                 |                    |
| Text Book<br>( Max. 2)   | Title                       | Water Wave Mechanics for Engineers and Scientists, Dean and Dalrymple |                 |                    |
|  | Author                      | Dean and Dalrymple  |                 |                    |
|  | Publisher                   | McGrawHill Book Co., New York   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       | Oceanographical Engineering,  |                 |                    |
|  | Author                      | Wiegel  |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     | 2002  |                 |                    |
| Reference Books  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |
|  | Title                       |   |                 |                    |
|  | Author                      |   |                 |                    |
|  | Publisher                   |   |                 |                    |
|  | Edition                     |   |                 |                    |

|            |  |  |
|------------|--|--|
|            | Author   |  |
|            | Publisher  |  |
|            | Edition  |  |
| Content    | <p>Introduction : The coastal zone and its study, Introduction to water waves, Classification of waves, A review of potential flow fundamentals , Wave properties</p> <p>Derivation of linear wave theory, Calculation of wave length, L, methods, Calculation of pressure, velocity, acceleration, Calculation of energy, group celerity, tables, Superposition of waves and standing waves, Energy and energy propagation in waves</p> <p>Shoaling of waves, Wave transformations, Refraction of waves, Diffraction of waves, Wave breaking in deep and shallow water, Winds over the sea and wave generation, Wave prediction</p> <p>Wave forces on pile structures ,Wave forces on wall type structures Rubble-mound stability, Hudson formula, Testing of Models in Wave Flumes</p> <p>Tides, Water levels ,Nonlinear waves, Introduction to different types of offshore structures</p> <p>Basic shore processes ,Shore protection alternatives, Artificial beach nourishment</p> |  |
| Course No. | CEL518   |  |

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**Department : Civil Engineering**

|  |                                  |   |                 |                    |  |
|--|----------------------------------|---|-----------------|--------------------|--|
| Course No.   | CEL 431                          | Open Course (Y/N)   | HM Course (Y/N) | Discontinued (Y/N) |  |
| Course Title   | Water Quality Modelling          |   |                 |                    |  |
| Course Coordinator   |                                  |   |                 |                    |  |
| Slot in which offered. If not offered write N                    | Odd                              |   | Even            |                    |  |
| Structure  | Lecture                          | Tutorial  | Practical       | Credits            |  |
|  | 3                                | 0   | 0               | 6                  |  |
| Prerequisite Course Codes As per proposed Course Numbers         | Fluid Mechanics II ( old scheme) |   |                 |                    |  |
| Prerequisite credits   |                                  |   |                 |                    |  |
| Equivalent Course Codes. As per proposed courses and old courses |                                  |   |                 |                    |  |
| Overlap course codes As per proposed Course Numbers              |                                  |   |                 |                    |  |
| Text Book ( Max. 2)  | Title                            | Introduction to Env. Engg and Science                     |                 |                    |  |
|  | Author                           | Gilbert M. Masters  |                 |                    |  |
|  | Publisher                        | Pramtice-Hall, India                                      |                 |                    |  |
|  | Edition                          |   |                 |                    |  |
|  | Title                            | Principles of Surface Water Quality Modelling and control |                 |                    |  |
|  | Author                           | Thomann, R.V. and Muller , J.A.                           |                 |                    |  |
|  | Publisher                        | Harper International Edition                              |                 |                    |  |
|  | Edition                          | 1984  |                 |                    |  |
| Reference Books  | Title                            | Water Quality   |                 |                    |  |
|  | Author                           | Tchobanoglous G. Schroeder , ED                           |                 |                    |  |
|  | Publisher                        | Addison-Wesley Publishing Co. Reading Massachusetts       |                 |                    |  |
|  | Edition                          |   |                 |                    |  |
|  | Title                            |   |                 |                    |  |
|  | Author                           |   |                 |                    |  |
|  | Publisher                        |   |                 |                    |  |
|  | Edition                          |   |                 |                    |  |
|  | Title                            |   |                 |                    |  |
|  | Author                           |   |                 |                    |  |
|  | Publisher                        |   |                 |                    |  |
|  | Edition                          |   |                 |                    |  |
|  | Title                            |   |                 |                    |  |
|  | Author                           |   |                 |                    |  |
|  | Publisher                        |   |                 |                    |  |
|  | Edition                          |   |                 |                    |  |

|            |  |  |
|------------|--|--|
|            | Publisher  |  |
|            | Edition  |  |
| Content    | Definition; Classification; Example and Models of Hydrology Systems.<br>Introduction to river, estuarine and lake thermodynamics, Stratification of lakes, Dissolved Oxygen Model for streams, Temperature Models, Predication of fate of organisms and toxic substances.<br>Models for predicting water quality changes in water distribution systems.<br>Computational methods in Environmental Modelling. |  |
| Course No. | CEL431   |  |

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### Course Content Proforma

**Department :** Civil Engineering

|  |         |                                 |  |                    |         |
|--|---------|---------------------------------|--|--------------------|---------|
| Course No.   | CEL 432 | Open course (Y/N)               | HM Courses (Y/N)   | Discontinued (Y/N) |         |
|  |         |                                 |  |                    |         |
| Course Title   |         | Environmental Impact Assessment |  |                    |         |
| Course Coordinator   |         |                                 |  |                    |         |
| Slot in which offered. If not offered write N                    |         | Odd                             |  | Even               |         |
|  |         | -                               |  | H                  |         |
| Structure  |         | Lecture                         | Tutorial   | Practical          | Credits |
|  |         | 3                               | 0  | 0                  | 6       |
| Prerequisite Course Codes As per proposed Course Numbers         |         | -                               |  |                    |         |
| Prerequisite credits   |         |                                 |  |                    |         |
| Equivalent Course Codes. As per proposed courses and old courses |         | CEL458                          |  |                    |         |
| Overlap course codes As per proposed Course Numbers              |         |                                 |  |                    |         |
| Text Book<br>( Max. 2)   |         | Title                           | Environmental Impact Assessment of Water Resource Projects |                    |         |
|  |         | Author                          | Canter L.  |                    |         |
|  |         | Publisher                       | McGraw Hill  |                    |         |
|  |         | Edition                         | 1996   |                    |         |
|  |         | Title                           | Environmental Impact Analysis Handbook                     |                    |         |
|  |         | Author                          | Rau G. L. and Wooten C. D.                                 |                    |         |
|  |         | Publisher                       | McGraw Hill  |                    |         |
|  |         | Edition                         | 1980   |                    |         |
| Reference Books  |         | Title                           |  |                    |         |
|  |         | Author                          |  |                    |         |
|  |         | Publisher                       |  |                    |         |
|  |         | Edition                         |  |                    |         |
|  |         | Title                           |  |                    |         |
|  |         | Author                          |  |                    |         |
|  |         | Publisher                       |  |                    |         |
|  |         | Edition                         |  |                    |         |
|  |         | Title                           |  |                    |         |
|  |         | Author                          |  |                    |         |
|  |         | Publisher                       |  |                    |         |
|  |         | Edition                         |  |                    |         |
|  |         | Title                           |  |                    |         |
|  |         | Author                          |  |                    |         |
|  |         | Publisher                       |  |                    |         |
|  |         | Edition                         |  |                    |         |
|  |         | Title                           |  |                    |         |
|  |         | Author                          |  |                    |         |
|  |         | Publisher                       |  |                    |         |
|  |         | Edition                         |  |                    |         |
|  |         | Title                           |  |                    |         |

|            |  |  |
|------------|--|--|
|            | Author   |  |
|            | Publisher  |  |
|            | Edition  |  |
| Content    | <p>Evolution and history of EIA at International and Indian level, Definition, benefits and importance of EIA, Environmental clearance process in India, EIA at project, regional and policy level, EIA process in India, Collection of baseline data, Identification of impacts on physical, biological, socioeconomic environment and land use pattern, Prediction and evolution of impacts, Screening and scoping criteria, Prediction models, EIA methodologies: checklist, matrix, overlay, BEES and other techniques of impact assessment, Uncertainties in EIA, Rapid and comprehensive EIA, Public participation in EIA, Environmental management plan, Post project monitoring, EIA reports, Environmental impact statement, Application of EIA for water resource projects, industrial projects, infrastructural projects etc.</p> |  |
| Course No. | CEL 432  |  |

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### Course Content Proforma

**Department :** Civil Engineering

|  |        |                         |                    |   |         |
|--|--------|-------------------------|--------------------|---|---------|
| Course No.   | CEL433 | Open Course<br>(Y/N)    | HM Course<br>(Y/N) | Discontinued (Y/N)                          |         |
| Course Title   |        | Water Power Engineering |                    |   |         |
| Course Coordinator   |        | Prof. A. D. Vasudeo     |                    |   |         |
| Slot in which offered. If not offered write N                          |        | Odd                     |                    | Even  |         |
|  |        | D                       |                    |   |         |
| Structure  |        | Lecture                 | Tutorial           | Practical                                   | Credits |
|  |        | 3                       | 0                  | 0   | 6       |
| Prerequisite Course Codes<br>As per proposed Course<br>Numbers         |        | Fluid Mechanics II      |                    |   |         |
| Prerequisite credits   |        |                         |                    |   |         |
| Equivalent Course Codes. As<br>per proposed courses and old<br>courses |        |                         |                    |   |         |
| Overlap course codes<br>As per proposed Course<br>Numbers              |        |                         |                    |   |         |
| Text Book<br>( Max. 2)   |        | Title                   |                    | Applied Hydraulic Transients,               |         |
|  |        | Author                  |                    | Hanif Chaudhary                             |         |
|  |        | Publisher               |                    | Van Nostrand Rein Hold Company, New<br>York |         |
|  |        | Edition                 |                    |   |         |
|  |        | Title                   |                    | Hydraulic Transients                        |         |
|  |        | Author                  |                    | Streeter V. L., and Wylie E. B.,            |         |
|  |        | Publisher               |                    | Mcgraw – Hill Book Company, New York        |         |
|  |        | Edition                 |                    |   |         |
| Reference Books  |        | Title                   |                    | Applied Hydraulic Transients,               |         |
|  |        | Author                  |                    | Hanif Chaudhary                             |         |
|  |        | Publisher               |                    | Van Nostrand Rein Hold Company, New<br>York |         |
|  |        | Edition                 |                    |   |         |
|  |        | Title                   |                    |   |         |
|  |        | Author                  |                    |   |         |
|  |        | Publisher               |                    |   |         |
|  |        | Edition                 |                    |   |         |
|  |        | Title                   |                    |   |         |
|  |        | Author                  |                    |   |         |
|  |        | Publisher               |                    |   |         |
|  |        | Edition                 |                    |   |         |
|  |        | Title                   |                    |   |         |
|  |        | Author                  |                    |   |         |
|  |        | Publisher               |                    |   |         |
|  |        | Edition                 |                    |   |         |
| Title  |        |                         |                    |   |         |
| Author   |        |                         |                    |   |         |
| Publisher  |        |                         |                    |   |         |
| Edition  |        |                         |                    |   |         |
| Title  |        |                         |                    |   |         |

|            |   |  |
|------------|---|--|
|            | Author  |  |
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <p>Water Power :Introduction Sources of Energy , Role of Hydropower in a plant system, Estimation of water power potential.</p> <p>Electrical Load on Hydro Turbines : Load Curve, load Factor, Capacity Factor, utilization factor, Diversity Factor, load Duration Curve, Firm Power, Secondary Power , Prediction of load.</p> <p>Types of hydro power plant : classification of hydel plants, Run of river plants, General Arrangements of Run of River Plants, Valley Dam plants, Diversion Canal Plants, High Head diversion plants, Storage and pondage , Pumped storage power palnts, Advantages of Pumped storage power palnts, Types of Pumped storage power palnts.</p> <p>Penstocks : General classification, design criteria, Economical diameter , Anchor blocks, Conduit valves, Bends and manifolds.</p> <p>Turbines : Introduction, main types of turbines, Hydraulics of turbines, Velocity Triangles and nomenclature, Basic flow equations, Draft tubes, Caviation in turbines, Turbine model testing, characteristics of turbines.</p> <p>Water Hammer and Surges : Introduction, Water Hammer, Transients caused by turbine, Load acceptance and rejection, Resonance in Penstocks, Channel Surges, Surge tanks. Intakes : types, losses, Air entertainment, Canals, Forebay, Tunnel.</p> |  |
| Course No. | CEL433  |  |

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### Course Content Proforma

|  |  |  |                    |                       |
|--|--|--|--------------------|-----------------------|
| Course No.   | CEP406                                     | Open course<br>(Y/N)                             | HM Course<br>(Y/N) | Discontinued<br>(Y/N) |
| Course Title   | <b><u>Advanced Concrete Technology</u></b> |  |                    |                       |
| Course Coordinator   | Dr. A. D. Pofale / A.G. Tawalare           |  |                    |                       |
| Slot in which offered. If not offered write N                    | Odd  |  | Even               |                       |
|  |  |  | H                  |                       |
| Structure  | Lecture                                    | Tutorial   | Practical          | Credits               |
|  | 3  | 0  | 0                  | 6                     |
| Prerequisite Course Codes<br>As per proposed Course Numbers      | 3CE***<br>Concrete Engineering             |  |                    |                       |
| Prerequisite credits   |  |  |                    |                       |
| Equivalent Course Codes. As per proposed courses and old courses | CEL487<br>Advanced Concrete Technology     |  |                    |                       |
| Overlap course codes<br>As per proposed Course Numbers           | CEL487<br>Advanced Concrete Technology     |  |                    |                       |
| Text Book<br>(Max. 2)  | Title                                      | Concrete Technology                              |                    |                       |
|  | Author                                     | Gambhir M.L.                                     |                    |                       |
|  | Publisher                                  | Tata McGraw Hill                                 |                    |                       |
|  | Edition                                    | (Second Edition) 1995                            |                    |                       |
|  | Title                                      | Concrete Technology                              |                    |                       |
|  | Author                                     | M.S.Shetty                                       |                    |                       |
|  | Publisher                                  | S.Chand & Company New Delhi                      |                    |                       |
|  | Edition                                    | 2005   |                    |                       |
| Reference Books  | Title                                      | Concrete microstructure, properties & materials, |                    |                       |
|  | Author                                     | P.Kumar Mehata, Paulo & J.M. Monteiro,           |                    |                       |
|  | Publisher                                  | Prentice Hall INC & Mcgraw Hill USA              |                    |                       |
|  | Edition                                    |  |                    |                       |
|  | Title                                      | Light Weight Concrete,                           |                    |                       |
|  | Author                                     | Short & Kenniburg,                               |                    |                       |
|  | Publisher                                  | Asia Publishing House, Bombay                    |                    |                       |
|  | Edition                                    | 1963   |                    |                       |
|  | Title                                      | Concrete Technology -Vol I. & II                 |                    |                       |
|  | Author                                     | Orchard D.F.;                                    |                    |                       |
|  | Publisher                                  | Applied Science Publishers                       |                    |                       |
|  | Edition                                    | (Fourth Edition) 1979                            |                    |                       |
|  | Title                                      | Properties of Concrete                           |                    |                       |
|  | Author                                     | Neville A.M., J.J.Brook                          |                    |                       |
|  | Publisher                                  | Addison Wesley                                   |                    |                       |
|  | Edition                                    | 1999   |                    |                       |

|            |   |  |
|------------|---|--|
|            | Title   |  |
|            | Author  |  |
|            | Publisher   |  |
|            | Edition   |  |
| Content    | <ol style="list-style-type: none"> <li>1. Review of properties of cement, their physical and chemical properties, special purpose cements, Classification and properties of aggregates, soundness of aggregates, alkali aggregate reaction, thermal properties of aggregates, Importance of shape and Surface area and grading, gap graded and aggregates. Admixtures &amp; construction chemicals, Use of Fly Ash, Silica Fumes, Metakaolin &amp; GGBS in concrete</li> <li>2. Rheological behavior of concrete, requirements of workability of concrete, Effect of environmental conditions, Strength properties of hardened concrete, Impact, Dynamic and fatigue behaviour of concrete, shrinkage and creep of concrete, behaviour of concrete under fire.</li> <li>3. Permeability and Durability of concrete, Parameters of durability of concrete, chemical attack on concrete, Production of concrete; batching mixing, transportation, placing, compaction of concrete. Special methods of concreting and curing of concrete, Hot weather and cold weather concreting, Guniting (Shotcreting)</li> <li>4. Concrete mix design, Basic considerations and choice a mix proportions, various methods of mix designs including IS Code method. Quality control and quality assurance of concrete, Acceptance criteria, Quality management in concrete construction, Inspection and testing of concrete. Non-destructive testing of concrete, core test and load test.</li> <li>5. Special concrete such as high strength, Lightweight, heavy weight, vacuum processed concrete, Mass concrete, high performance concrete, Pumpable concrete, Self Compacting concrete, Air entrained concrete, Ferro cement, fiber reinforced concrete, Polymer impregnated concrete. Jet concrete. Deterioration and repair technology of concrete, Distress and type of repairs, crack sealing techniques</li> </ol> |  |
| Course No. |   |  |

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**Programme Requirement Table**  
**Department of Civil Engineering**  
**M. Tech (Water Resources Engineering)**  
**Year of Admission 2009**  
**Overall Credit Structure**

| Post graduate core (PC)          |              | Postgraduate Electives (PE) |              |
|----------------------------------|--------------|-----------------------------|--------------|
| Category                         | Credit       | Category                    | Credit       |
| DC                               | 68-74        | DE                          | 30-36        |
|                                  |              |                             |              |
| <b>Total</b>                     | <b>68-74</b> | <b>Total</b>                | <b>30-36</b> |
| <b>Grand Total (PC + PE) 104</b> |              |                             |              |

| Course Code                       | Course                                       | Structure | Credits |
|-----------------------------------|--|-----------|---------|
| <i>Departmental Core, DC</i>      |  |           |         |
| MAL 402                           | Numerical solution of Differential Equations | 3-0-0     | 6       |
| CEL 426                           | Groundwater Hydrology                        | 3-0-0     | 6       |
| CEL 427                           | Free Surface Flows                           | 3-1-0     | 8       |
| CEL 428                           | Water Resources Systems                      | 3-0-0     | 6       |
| CEL 412                           | Spatial Analyses for Resources Management *  | 3-0-2     | 8       |
| CEL 514                           | Applied Surface Hydrology                    | 3-0-0     | 6       |
| CEP 503                           | Water Resources Engineering Laboratory       | 0-0-4     | 4       |
| CED 501                           | Project Phase I                              | 0-0-0     | 6       |
| CED 502                           | Project Phase II                             | 0-0-0     | 18      |
|                                   |  |           | 68      |
| <i>Departmental Electives, DE</i> |  |           |         |
| CEL 429                           | Close Conduit Flows                          | 3-0-0     | 6       |
| CEL 419                           | River Engineering                            | 3-0-0     | 6       |
| CEL 414                           | Water Distribution Systems                   | 3-1-0     | 8       |
| CEL 430                           | Hydraulic Structures I *                     | 2-1-0     | 6       |
| CEL 420                           | Earthen Dams *                               | 3-1-0     | 8       |
| CEL 515                           | Advanced Fluid Mechanics                     | 3-0-0     | 6       |
| CEL 516                           | Modeling Techniques *                        | 3-0-0     | 6       |
| CEL 517                           | Hydraulic Structures II                      | 2-1-0     | 6       |
| CEL518                            | Coastal Engineering *                        | 3-0-0     | 6       |
| CEL431                            | Water Quality Modeling *                     | 3-0-0     | 6       |
| CE                                | Mini Project                                 | 0-0-0     | 4       |
| CE                                | Seminar                                      | 0-0-0     | 2       |
| CEL 432                           | Environmental Impact Assessment              | 3-0-0     | 6       |
| CEL 433                           | Water Power Engineering                      | 3-0-0     | 6       |
| CEL 406                           | Advanced Concrete Technology                 | 3-0-0     | 6       |
|                                   |  |           | 36      |

\* Subject to approval from Senate.

