# Four Semester Master of Engineering Course in Water Resources and Hydraulic Engineering

**OFFERED BY:** School of Water Resources Engineering, Faculty of Engineering and Technology, Jadavpur University

**APPROVED BY:** All India Council for Technical Education (AICTE)

## Credit Points, Periods / Week, Marks

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credit Points</th>
<th>Periods / Week</th>
<th>Marks</th>
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<tr>
<td></td>
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<td>Exam.</td>
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<tr>
<td><strong>First Semester</strong></td>
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<td></td>
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<tr>
<td>Three papers from Departmental Basket</td>
<td>3 × 3</td>
<td>3 × 3</td>
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<tr>
<td>Three papers from Interdisciplinary Basket</td>
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<tr>
<td>Laboratory I</td>
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<tr>
<td>Seminar I</td>
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<td><strong>Second Semester</strong></td>
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<tr>
<td>Term Paper Leading to Thesis</td>
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<td>Laboratory II</td>
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<td>Thesis/Project/Dissertation</td>
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<td><strong>Grand Total</strong></td>
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1st SEMESTER:

Departmental Basket of SWRE

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the Subject</th>
<th>Course No.</th>
<th>To be offered by</th>
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<tbody>
<tr>
<td>Paper 1</td>
<td>Aquatic Ecology and Environment</td>
<td>PG/DB/SWRE/01</td>
<td>School of Water Resources Engineering</td>
</tr>
<tr>
<td>Paper 2</td>
<td>Irrigation and Agronomy or, Geophysical Fluid Dynamics</td>
<td>PG/DB/SWRE/02</td>
<td>School of Water Resources Engineering</td>
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<td></td>
<td></td>
<td>PG/DB/SWRE/03</td>
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<tr>
<td>Paper 3</td>
<td>Hydraulic Structure and Hydel Power Engineering or, Hydraulics and Sediment Transport</td>
<td>PG/DB/SWRE/04</td>
<td>School of Water Resources Engineering</td>
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Interdisciplinary Basket of SWRE

<table>
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<th>No.</th>
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<tr>
<td>Paper 4</td>
<td>Principle of Water Resources Engineering</td>
<td>PG/Int-B/SWRE/06</td>
<td>School of Water Resources Engineering</td>
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<tr>
<td>Paper 5</td>
<td>Water Works Engineering</td>
<td>PG/Int-B/SWRE/07</td>
<td>School of Water Resources Engineering</td>
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<td>Paper 6</td>
<td>Free Surface Flow</td>
<td>PG/Int-B/SWRE/08</td>
<td>School of Water Resources Engineering</td>
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</tbody>
</table>

N.B. : Other subjects belonging to the interdisciplinary basket are also being offered by the other Departments/Schools of Jadavpur University

sigmoid Laboratory – I : Water and Wastewater Analysis Laboratory and Hydrology Laboratory

sigmoid Seminar - I
2\textsuperscript{nd} SEMESTER:

**Departmental Basket of SWRE**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the Subject</th>
<th>Course No.</th>
<th>To be offered by</th>
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<tbody>
<tr>
<td>Paper 7</td>
<td>Advanced Hydrology or, Computational Hydro Dynamics</td>
<td>PG/DB/SWRE/09, PG/DB/SWRE/10</td>
<td>School of Water Resources Engineering</td>
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<tr>
<td>Paper 8</td>
<td>Ground Water Dynamics or, River Hydraulics and Engineering</td>
<td>PG/DB/SWRE/11, PG/DB/SWRE/12</td>
<td>School of Water Resources Engineering</td>
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<tr>
<td>Paper 9</td>
<td>Design of Water Resources System</td>
<td>PG/DB/SWRE/13</td>
<td>School of Water Resources Engineering</td>
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**Interdisciplinary Basket of SWRE**

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<tr>
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<th>Course No.</th>
<th>To be offered by</th>
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<tr>
<td>Paper 10</td>
<td>Water Resources Management or, Economics and Legal Aspects of Water Resources</td>
<td>PG/IntB/SWRE/14, PG/IntB/SWRE/15</td>
<td>School of Water Resources Engineering</td>
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</tbody>
</table>

N.B. : Other subjects belonging to the interdisciplinary basket are also being offered by the other Departments/Schools of Jadavpur University

- Laboratory – II: Application Software Laboratory and Fluvial Hydraulics Laboratory
- Term paper leading to Thesis
- Seminar - II

3\textsuperscript{rd} and 4\textsuperscript{th} SEMESTER:

- Thesis and Vivavoce
SYLLABI
for
THE MASTER OF ENGINEERING IN WATER RESOURCES and HYDRAULIC ENGINEERING

Departmental Basket

PG/DB/SWRE/01 Aquatic Ecology and Environment
Greenhouse effect, Climate change, Global energy balance, Carbon cycle, Oxygen cycle, nitrogen, sulphur, phosphorous and other nutrients, Lakes and reservoirs, Dissolved oxygen balance and model, Water pollution and aquatic eco-system, Water and wastewater analysis, Municipal solid waste disposal techniques-leachate generation model, Extreme events, Environmental impact assessment (EIA), Environmental audit, etc.

Books :
1. Introduction to Environmental Engineering and Science : Gilbert M. Masters, Prentice Hall of India
2. Environmental Engineering : Howard S. Peavy and Donald R. Rowe, McGraw Hill Book Company
5. Water and Wastewater Technology : Mark J. Hammer, Prentice-Hall of India

PG/DB/SWRE/02 Irrigation and Agronomy
Irrigation techniques and quality of irrigation water, Water requirement of crops, Soil moisture irrigation relationship, Water resources utilization and irrigation development, Investigation and preparation of irrigation projects, Methods of irrigation and water rates, Water use management, Measurement of water, Water logging and land reclamation, Causes and control of water logging, Improvement of irrigation efficiencies, Benefit cost ratios, Canal irrigation system, Design of irrigation channels, Lining of irrigation lands including definition and types, Economics of lining, Surface and sub-surface drainage, Estimation of crop water requirement, Estimation of irrigation water requirement, Scheduling irrigation, etc.

Agronomy and agro-ecosystem, Soil and its composition, Crop productivity, Climate and zoning, Soil fertility and fertilizer, Plant-water relation, Soil and water conservation, etc.

Books :
1. Irrigation Water Management (Principles and Practice): Dilip Kumar Majumdar, Prentice Hall of India
2. Irrigation Engineering and Hydraulic Structure : Santosh Kumar Garg, Khanna Publication
5. Irrigation Engineering: Asawa, New Age International (P) Ltd.
6. Soil and Water Conservation Engineering : Glen Schwabelliot and Glen Schwab, Wiley

PG/DB/SWRE/03 Geophysical Fluid Dynamics

Books :
1. Geophysical Fluid Dynamics : R.S. Long
4. Geophysical Fluid Dynamics: Joseph Pedlosky, Springer
5. Introduction to Geophysical Fluid Dynamics: Benoit Cushman-Roisin, Prentice Hall
Hydraulic Structure and Hydel Power Engineering

Theories of seepage, Wave theory, Dams and barrages, Design of weirs and barrages, Dams in general – types and selection, Designing of reservoir capacity with capacity-elevation and area-elevation curves of a reservoir site, Design and construction of gravity dams, Water conveying channels and structures, Penstocks, Water hammer and surge tanks, Gates in hydraulic installations, Spillways, River training and control works, Wind generated waves, Shallow and deep water waves, Storm surges, Harbour resonance, Hydraulic loading on structures – static and dynamic effects, Codes of practice, Design and construction of offshore structures, Water for hydroelectric generation, Tidal power – Principle, Components, Ebb-cycle, Tide-cycle, Estimate of energy and power, etc.

Books:
6. Hydraulic Structures: Novak, Taylor and Francis

Hydraulics and Sediment Transport

Real-fluid flow, viscous incompressible flow, Navier-Stokes equations, RANS, Laminar and turbulent boundary layer, Turbulence and coherent structure of flow, Reynolds stresses, Skin friction, Form drag and lift, Flow in pipes and closed conduits, Pressure surge in conduits, Hydraulic conduits, etc.

Books:
2. Sediment and Ecohydraulics (INTERCOH 2005): Tetsuya Kusuda (Contributor: Hiroyuki Yamanishi, Jeremy, Spearman, Joseph Z. Gailani), Elsevier Publisher
5. Sediment Transport (in 3 parts), ASCE: Leo C. van Rijn

Principle of Water Resources Engineering

Water resources – global perspective, Fields of water resources engineering, Hydrological cycle, Precipitation and its measurement, Raingauge networking, Precipitation data processing and analysis, Abstractions of precipitation, Hydrological data and their measurements, Streamflow measurement and analysis, Runoff – flow-duration curve, Flow mass curve, Hydrograph – its components, UH, S-curve, IUH, Flood routing, Hydrologic storage routing and channel routing, Flood flows – estimation and control measures, Flood forecasting techniques, Surface water and storage reservoir, Conveyance of surface water through river intakes and dam outlet, Groundwater hydrology – Well hydraulics, Drainage and reclamation of water logged lands, Water quality,
Desalination of brackish water, Cost benefit considerations in water resources planning etc.

Books:
1. Water Resources Engineering : Larry W. Mays, John Wiley and Sons
4. Engineering Hydrology : R. S. Varshney, Nem Chand Publisher

PG/Int-B/SWRE/07 Water Works Engineering

Water quality, Water treatment processes, Basic design consideration, Pre-design, Raw water intake, Screening and aeration, Water conveyance, Flow measurement and pumping, Coagulation, Flocculation and Precipitation, Sedimentation, filtration, colour, taste and odor control, Disinfections and fluoridation, Water quality, Clear well, High service pumps and distribution system, Residual processing and disposal, Plant siting, layout, Yard piping and hydraulic profile, Process control, Non conventional water treatment processes and design etc.

Books
1. Water Treatment Plant Design : ASCE and AWWA
5. Water Treatment - Trouble Shooting and Problem Solving : G.M. Tillman, Taylor and Francis Ltd
7. Elements of Water Supply and Wastewater – Fair, G.M.; Gayer, J.C. and Okun, D.A. Willey

PG/Int-B/SWRE/08 Free Surface Flow

Classification, Energy and momentum in free surface flow, Critical flow, Uniform flow, Design of non-erodible, Erodible channels and grassed channels, Concepts of boundary layer, Surface roughness, Velocity distribution and instability of uniform flow, Gradually varied flow – spatially varied flow, rapidly varied flow, Flow over spillways, Supercritical flows and oblique flows, Hydraulic jump, Gradually varied and rapidly varied unsteady flow, Wave propagation and surge in canals, Discharge measuring methods, Free surface flow in closed conduits, etc.

Books:
2. Hand Book of Applied Hydraulics : Calvin Victor Davis and Kenneth E. Sorensen
3. Open-Channel Flow : M. Hanif Choudhury, Prentice Hall of India
**Advanced Hydrology**

Hydrograph, Distribution graph for runoff generation, Complex storm hydrograph, Synthetic UH generation techniques, IUH generation techniques, UH generation from IUH, SCS runoff curve number method, Snow hydrology, Snow formation and accumulation, Melting of snowpack, Snowmelt indices, Effect of snowpack condition on runoff, Snowmelt hydrograph synthesis, Fluvial geomorphology, Models for hydrologic abstraction processes, Aspects of arid zone hydrology, Probable maximum precipitation – Estimation, Types of catchment model components and Construction, Analysis of time series data – Generation of synthetic hydrologic data, Forest hydrology, etc.

**Books:**
8. Facets of Hydrology : (Ed.) J. C. Rodda, John Wiley and Sons
10. Hydrology: An Introduction to Hydrologic Science : By Rafael L. Bras
11. Introduction to Hydrology : Warren Viessman, John W. Knapp, Gary L. Lewis, IEP Publisher

**Computational Hydro Dynamics**


**Books:**
5. Computational Fluid Dynamics: Principles and Applications : J. Blazek, Elsevier Science

**Ground Water Dynamics**

Occurrence of groundwater – origin and distribution of groundwater, Geologic formation as aquifers, Groundwater movement, Groundwater flow in unsaturated zones and fractured media, Hydro-geologic investigation, 3-D general flow equations, Groundwater and well hydraulics, Response of confined and unconfined aquifers to pumping, Leaky confined aquifers and partially penetrating wells, surface and subsurface investigation of groundwater, Artificial recharge, Saline water intrusion, Groundwater modeling, etc.

**Books:**
2. Fundamentals of Groundwater: Franklin W. Schwartz, Hubao Zhang, Publisher Wiley
3. Water Resources Engineering: Ralph A. Wurbs and Wesley P. James, Prentice Hall of India
5. Ground Water: H. M. Raghunath, New Age International Publishers
7. Environmental Geology-An Earth System Science Approach: Dorothy Merritts, Andrew De Wet and Kirsten Menking
9. Groundwater Resources Development: L. Hamill and F. J. Bell, Butterworth Publisher

PG/DB/SWRE/12 River Hydraulics and Engineering

River morphology, Meandering, Sediment transport, Measurement of stream flow and sediment, Stabilization and rectification of rivers, Dredging, Inland navigation, Canalization, Diversion and cofferdams, Levees and associated flood control works, River model, Channel control and Transitions, Discharge measurement methods, Flow resistance, Composite roughness and compound channels, Continuity and dynamic equations of unsteady flow, Method of characteristics, Dam-break problem, Density current, Flow in channel bends, Tides and surges in rivers, etc.

Books:
1. River Engineering: Margaret S. Petersen, Prentice Hall of India
2. Fundamentals of Fluvial Geomorphology: Ro Charlton, Routledge, Taylor and Francis Group

PG/DB/SWRE/13 Design of Water Resources System

Feasibilities of water resources development, Planning alternatives, Storm water management: Design of storm sewers and detention, Highway drainage and culverts, Spillway and energy dissipater, Pipeline distribution network, Probability risk and uncertainty analysis, Design of water harvesting structures, Design of water intake stations, Design of water treatment plant, Design of irrigation systems, etc.

Books:
4. Water Resources Systems Planning and Management (Developments in Water Science): Sharad Kumar Jain, V. P. Singh, Elsevier
5. Water Resources Engineering: Larry W. Mays, John Wiley and Sons
6. Water Resources Engineering: Ralph A. Wurbs and Wesley P. James, Prentice Hall of India

Interdisciplinary Basket

PG/Int-B/SWRE/14 Water Resources Management

Management of hydrological data, Linear Programming and its application in water resources development, Inventory control, Analysis of risk and uncertainties, Dynamics programming Statistical decision model, Water policies and institutional aspects of management of water resources, Hierarchical modeling of water resources development, Management of watersheds and water quality, Reservoir and stream flow routing, probability, Risk and uncertainty analysis, etc.
Urban water supply planning/management, Cost-benefit analysis in water resources planning, Planning of watersheds, Watershed behavior and conservation practices, Trans-boundary water resources, National water policy, water withdrawals and uses, etc.

Books:
1. Water Management (Technology and Institutions) : Warren Viessman Jr. and Claire Welty, Harper and Row Publisher
2. Water Resources Systems Planning and Management (Developments in Water Science) : Sharad Kumar Jain, V. P. Singh, Elsevier
3. Water Resources Engineering : Larry W. Mays, John Wiley and Sons
4. Water Resources Engineering : Ralph A. Wurbs and Wesley P. James, Prentice Hall of India
5. Modeling Water Qualities and Management : Asit K. Biswas
8. Sustainable Water Management Solutions for Large Cities : Dragan A. Savic and Mignel A.

PG/Int-B/SWRE/15 Economics and Legal Aspects of Water Resources
Eco-system, Interrelation of ecological elements in cultural landscape, Ecological zoning, Ecology of river, lake, Estuaries wetlands etc., Conservation of wetlands, Principles of law applied to water rights and water allocation, Analysis of the laws and administrative structure that constitute the institutional framework of the environmental aspects of water resources management, Order in priorities, Legislation of different uses of water, Legislation on harmful effects of water, Controlling the use of water, Environmental constraints on water development project, Declaration of protected areas of zones, Water quality standards for drinking water, Standards for water re-use, International aspects of water, International Water Resources Law, International case law, International and Bilateral Rivers.

Books:
2. Water Law in Historical Perspective: L.A. Teclaff, Hein and co., Buffalo, N.Y.
3. Environmental Law and Policy in India : S. Divam and A. Rosencrapn, OUP
5. Integrated Environmental Planning : James K. Lein, Blackwell publisher

Laboratory – I: Water and Wastewater Analysis Laboratory and Hydrology Laboratory
1. Rainfall Data collection by Natural Syphon Recording type Raingauge and determination of mass curve and hyetograph from the obtained chart
2. Determination of infiltration rate by Double Ring type Infiltrometer
3. Measurement of permeability
4. Determination of rate of evaporation through Pan Evaporimeter

Determination of following parameters:

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<tr>
<th>No</th>
<th>Parameter</th>
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<tr>
<td>1</td>
<td>Dissolved Oxygen (DO)</td>
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<td>2</td>
<td>Turbidity</td>
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<td>3</td>
<td>Bio-chemical Oxygen Demand (BOD)</td>
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<tr>
<td>4</td>
<td>Sulphate</td>
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<td>5</td>
<td>Chemical Oxygen Demand (COD)</td>
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<td>6</td>
<td>Phosphate</td>
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<td>7</td>
<td>TSS (Total Suspended Solid)</td>
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<tr>
<td>8</td>
<td>Chloride</td>
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<tr>
<td>9</td>
<td>TDS (Total Dissolved Solid)</td>
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<td>10</td>
<td>pH Value</td>
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<td>11</td>
<td>Electrical Conductivity</td>
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<td>12</td>
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<td>13</td>
<td>Bacteriological Parameters</td>
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<td>14</td>
<td>Iron</td>
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15 Arsenic
17 Oil and Grease

Books:
1. Vogel's Qualitative Inorganic Analysis (17th Ed.) : G. Svehla, Pearson Education

Laboratory – II: Application Software Laboratory and Fluvial Hydraulics Laboratory

Application Software Laboratory:
1. G.I.S. Tool in Watershed Development
2. HEC-HMS Software
3. Water CAD Professional
4. Artificial Neural Network (ANN)
5. Surface Water Modelling System (SMS 9.0)
6. Ground Water Modelling System (GMS 6.0)
7. Visual Modflow

Fluvial Hydraulics Laboratory:
1. Field measurement of velocity by Current Meter (Propeller Type)
2. Velocity measurement by Pitot Tube
3. Velocity and Discharge measurement by Ultrasonic Flow Meter
4. Depth measurement by Echo-Sounder
5. Sieve Analysis Test

Field survey:
1. Field survey by Electronic Total Station
2. Bathymetric survey by Depth Echo Sounder
3. Groundwater level survey with Water Level Indicator
4. Field survey by Signal Stacking Resistivity Meter (VES)

Contact

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School of Water Resources Engineering,
Jadavpur University

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Fax : +91 33 2414-6161(Telefax) / 6886(D)
Email : asismazumdar@yahoo.com, swreju@yahoo.co.in
Website : www.waterresources-ju.org, www.jadavpur.edu/academics/schools.htm