INFORMATION BROCHURE
(2016-17)

For Admission to Post Graduate Programmes
in
Water Resources Development & Irrigation Water Management

Last date of receipt of Application Form is June 30, 2016
Experts from field and other Departments of IIT Roorkee and Scientists of other Institutes are also invited to deliver expert lectures.
One Year P.G. Diploma Programme
and
Two Year M.Tech. Degree Programme
in
WATER RESOURCES DEVELOPMENT
(For Civil, Electrical and Mechanical Engineers)
&
IRRIGATION WATER MANAGEMENT
(For Civil Engineers, Agricultural Engineers and Agricultural Scientists)

Department of
Water Resources Development and Management
(Formerly Water Resources Development Training Centre)
IIT Roorkee, ROORKEE – 247 667 (Uttarakhand) INDIA

Tel: + 91-1332-285251, 285951; Fax: +91-1332-271073, 273560
E-mail : wrdtec@iitr.ac.in & wrdmiitroorkee@gmail.com
Website : (http://www.iitr.ernet.in/departments/WRT/pages/index.html)
## IMPORTANT INFORMATION

The Department of Water Resources Development and Management (WRD&M), [formerly Water Resources Development Training Centre (WRDTC)] offers, for the sponsored candidates, P.G.Diploma and M.Tech. Programmes in addition to 12-month training programme. Processing of applications for admission and sponsorship takes considerable time. Therefore, the sponsored candidates should send their application well in time so that same could reach to the department at the earliest and latest by **June 30, 2016**. The Academic session will start in the second week of **July 2016 (14.07.2016)**.

The selected candidates shall be governed by rules and regulations of Indian Institute of Technology Roorkee (IITR). In case of any dispute in interpretation of these or any other matter not covered in the rules and regulations, the decision of the Chairman of the senate of IIT Roorkee shall be final and binding.

**NOTE :** The candidates working in Government/Semi government/PSU organization **ONLY** are eligible to apply through this information brochure.

For further information please visit the website or contact:

**Prof. S. K. Mishra**  
Head of the Department  
Department of Water Resources Development and Management  
Indian Institute of Technology Roorkee  
Roorkee - 247 667 (Uttarakhand) INDIA  
Ph: +91-1332-285251, 285951; Fax: +91-1332-271073, 273560  
E-mail : wrdttc@iitr.ac.in & wrdmiiitroorkee@gmail.com  
Website : (http://www.iitr.ernet.in/departments/WRT/pages/index.html)
The rising demand for water to meet the requirements for intrinsically connected water, food, energy and climate, such as for agriculture, industry, hydropower, municipal and rural water uses, and environmental flows has presented a challenge for the planners and water managers to strike a balance between demand and supply of water. To address such issues and to develop trained manpower to undertake complex works of Water Resources Development and Management in Asian, African and Latin American countries, the Department of Water Resources Development and Management (formerly known as Water Resources Development Training Centre) was founded on Nov. 25, 1955 as a follow up of Bandung Conference held in April 1954 due to the vision of Late Pt. Jawahar Lal Nehru, the first Prime Minister of India, and late Dr. A. N. Khosla, an Eminent Water Resources Engineer and the then Vice Chancellor of University of Roorkee presently known as Indian Institute of Technology Roorkee.

During the last 60 years, the Department has achieved a high level of performance in training the young minds and intellectuals with proper knowledge and goals. It has provided training to 2637 in-service water professionals of 50 friendly countries. It has earned its own level of reputation and fame globally by imparting knowledge and education to many students involving scientists and professionals from national and international organizations. Its alumni have contributed significantly in different fields all over the world and performed with excellence in the field of water resources. Many of them are occupying top-level decision-making positions in their organizations (Water/Irrigation/Agriculture etc.) in their countries/States.

The Department is unique due to the expertise available in the fields of planning, investigation, design, construction, operation and maintenance of River Valley Multipurpose Projects and Irrigation and Drainage Systems (large/medium/small). This is dedicated to very high quality Post Graduate Education and Specialized Training in the fields of Water Resources Development and Irrigation Water Management. Its faculty is outstanding and teaching has a unique blend of both practical and theoretical concepts. The department is very actively involved in research, consultancy, and extension activities. It is also noted as a centre of excellence in design of Water Resources Structures, Irrigation Planning and Management, Flood Control, Irrigation and Drainage and Hydro Power Development.

The Department has constantly endeavored to provide state-of-the-art education and training by keeping the curriculum abreast with the latest developments to meet the aspirations of trainees and their sponsoring agencies. It currently offers the following academic programmes:

1. **Water Resources Development (WRD) (for Civil, Electrical and Mechanical Engineers)**
   - Training (One year duration)
   - Post Graduate Diploma (Two Semester course)
   - Master of Technology (Four Semester course)

2. **Irrigation Water Management (IWM) (for Civil/Agricultural Engineers and Agricultural Scientists)**
   - Training (One year duration)
   - Post Graduate Diploma (Two Semester course)
   - Master of Technology (Four Semester course)

This brochure provides detailed information about its academic programmes. For admission, the proforma given is applicable for sponsored candidates only. Indian graduates are admitted through GATE for 12 (twelve) seats in WRD and 03 (three) seats in IWM programmes and these candidates are required to apply separately in response to IIT notifications/advertisements for postgraduate admissions. Agencies are requested to sponsor their officers for admission to various academic programmes of the Department.

(Prof. S. K. MISHRA)
Head of the Department
1.0 INTRODUCTION

1.1 General

In most of the developing countries of Asia, Africa and the Far East, droughts and floods continue to hamper agricultural production and other productive activities and cause widespread misery for want of adequate control on rivers. A large part of their surface water resources remain untapped for irrigation, flood control and hydropower potential because of their economic backwardness. The growing population and the urgency for food and economic betterment call for the need of efficient use and management of water resources to step up their agricultural and industrial production. Trained manpower to prepare plans to undertake Water Resources Development projects that yield into agricultural, industrial and economic development is needed by most of the developing countries. Mighty rivers when tamed by constructing dams, irrigation canals and hydropower stations can transform industrial and agricultural growth of a country. Investigation, planning, design and construction of such major river valley developments projects need a high degree of engineering skill and knowledge about design and construction practices. The need of trained manpower in Water Resources Development and Management for developing countries to undertake such a gigantic task was keenly felt in 1954 at Bandung Summit. Consequently this department was founded on Nov. 25, 1955 at the erstwhile University of Roorkee now Indian Institute of Technology Roorkee.

1.2 The Institute

Indian Institute of Technology Roorkee has its roots in the Roorkee College established in 1847 as the first engineering college in India, which was soon rechristened as Thomason College of Civil Engineering in 1854 after its greatest mentor James Thomason. After about 100 years of distinguished services, the college was elevated to University of Roorkee as the first Engineering University of Independent India on November 25, 1949. It has now 21 academic departments covering engineering, applied sciences, humanities & social sciences & management programme, 1 academic centre, 3 centres of excellence & 5 academic service centres.

Prior to becoming an IIT, the University of Roorkee was accredited by the National Assessment and Accreditation Council (NAAC), an autonomous institution of the University Grant Commission (UGC), with FIVE STARS (***** ) for a period of five years in the year 2000. This is the highest grade that NAAC awards on five point scale.

1.3 The Department

The proposal for establishing a training centre in Water Resources Development originated with the United Nations Economic Commission of Asia and the Far East (now known as ESCAP) some time in 1951-52 and the Centre was established at the erstwhile University of Roorkee on November 25, 1955. The essential equipment was provided under the then U.S. Technical Cooperation Mission and U.N. Technical Assistance Board. The government of India provided funds for the building and other facilities and agreed to bear the entire recurring expenditure. The USAID, UNDP and ECAEF provided specialists for short-term lecture arrangement.

The choice for opening the Centre fell on India, which had the unique distinction of having the biggest network of irrigation works, the largest area under irrigation and the greatest variety of irrigation structures. India also had, after attaining independence, embarked on an ambitious programme of construction of river valley projects. Erstwhile University of Roorkee being successor to the Thomason College of Civil Engineering the oldest and best-known technical institution in the East and having the basic infrastructure for imparting such training was obvious for establishing the Centre. Dr. A.N. Khosla, a legendary figure in the field of Water Resources Engineering and then Vice-Chancellor of the erstwhile University of Roorkee was the founder Director of the Centre. Consequent upon the conversion of University of Roorkee in Indian Institute of Technology Roorkee, the Water Resources Development Training Centre (WRDTC) was renamed as the Department of Water Resources Development and Management (WRD&M). The Department offers M.Tech. and Post-Graduate training programmes for specialization in the fields of Water Resources Development (for civil, electrical and mechanical engineers) and Irrigation Water Management (for civil engineers, agricultural engineers and agricultural scientists) separately.

1.4 The Campus

The campus of the Indian Institute of Technology Roorkee is located at an elevation of 268m (880 ft) above mean sea level (longitude 77°54'E and latitude of 29°52'N). The place is situated only 30-60km (19-35 miles) south of the foothills of the Himalayas (Haridwar and Rishikesh) and is within easy reach of New Delhi, the capital of India, at a distance of about 180 km by road. It is also connected by rail to Delhi, Bombay and almost all State's capitals.
The atmospheric temperature of Roorkee varies from 2.5°C (36.5°F) to 34°C (94°F) in winter and from 13°C (55°F) to 45°C (113°F) in summer. The annual rainfall averages 1041mm (41 inches), the bulk of which occurs during mid June to mid of September. The only hot months are May and June but these are not particularly uncomfortable. The rainy and winter months are generally pleasant. Clothes of cotton, silk or terylene and mosquito nets are required during summer and rainy seasons while woolen suits and blankets are essential during winter.

1.5 Medium of Instruction

The medium of instruction at the Department is English. Engineer trainees are expected to have sufficient and adequate working knowledge of English language.

1.6 Objective and Achievements

The Centre (now a Department) was established with the objective to train serving engineers from Asia, Africa and other developing countries in various aspects of Water Resources Development and to bring together engineering talent from these countries for a first-hand understanding and appreciation of each others problems and to help evolve, by pooling of knowledge, new techniques in water resources development and management suited to conditions of Afro-Asian region. In addition, the programme of education in the department helps foster a feeling of brotherhood amongst the engineers of various countries.

Since its creation in 1955, the department has trained 2637 serving engineers from 50 countries as detailed below:

<table>
<thead>
<tr>
<th>Name of Country</th>
<th>No. of Trainees</th>
<th>Name of Country</th>
<th>No. of Trainees</th>
<th>Name of Country</th>
<th>No. of Trainees</th>
<th>Name of Country</th>
<th>No. of Trainees</th>
<th>Name of Country</th>
<th>No. of Trainees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>31</td>
<td>Indonesia</td>
<td>501</td>
<td>Mangolia</td>
<td>1</td>
<td>Sri Lanka</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>17</td>
<td>Iran</td>
<td>1</td>
<td>Mexico</td>
<td>1</td>
<td>Sudan</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>1</td>
<td>Iraq</td>
<td>14</td>
<td>Myanmar</td>
<td>15</td>
<td>Syria</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhutan</td>
<td>2</td>
<td>Japan</td>
<td>1</td>
<td>Nicaragua</td>
<td>1</td>
<td>Tanzania</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>3</td>
<td>Jordan</td>
<td>2</td>
<td>Nigeria</td>
<td>1</td>
<td>Thailand</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costarica</td>
<td>1</td>
<td>Kenya</td>
<td>6</td>
<td>Nepal</td>
<td>131</td>
<td>UAE</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuba</td>
<td>1</td>
<td>Kazakhstan</td>
<td>2</td>
<td>Panama</td>
<td>1</td>
<td>Uganda</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>7</td>
<td>Lao PDR</td>
<td>9</td>
<td>Pakistan</td>
<td>1</td>
<td>Uzbekistan</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eritrea</td>
<td>1</td>
<td>Liberia</td>
<td>1</td>
<td>Philippines</td>
<td>42</td>
<td>Vietnam</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethiopia</td>
<td>20</td>
<td>Malawi</td>
<td>3</td>
<td>Sengal</td>
<td>1</td>
<td>Yeman</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ghana</td>
<td>11</td>
<td>Malaysia</td>
<td>7</td>
<td>Sierra Leone</td>
<td>2</td>
<td>Zambia</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guyana</td>
<td>1</td>
<td>Maldives</td>
<td>1</td>
<td>South Korea</td>
<td>3</td>
<td>Grand Total</td>
<td>2637</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>1599</td>
<td>Mauritius</td>
<td>1</td>
<td>Singapore</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.0 FACILITIES

2.1 General
The Department and the Institute have all the required facilities to provide training in the field of Water Resource Development and Irrigation Water Management of the international standard which are briefly described below:

2.2 Library
The Department has a library of its own which is equipped with the latest literature on the topics relating to Water Resources Engineering and Irrigation Water Management. The Department subscribes regularly several to important journals and other periodicals in these fields. The proceedings of many important conferences and symposia in the field of Water Resources Engineering and Irrigation Water Management are also available. Considerable effort and resources are devoted to keep the library up to date. About 12000 books and 2400 periodicals are available in the Departmental library. Apart from the departmental library, the Institute has modern well-equipped library housed in a separate air-conditioned block. It has literature on all engineering subjects.

2.3 Laboratories
The Department has its own laboratories of Soil Mechanics and Irrigation Water Management, Dam Stress, Rock Mechanics Groundwater and River Engineering and Electrical Testing for experimental work associated with classroom teaching, training and faculty research and consultancy. In addition to departmental laboratories, excellent laboratory facilities are also available in the Departments of Civil, Electrical, Hydrology, Mechanical, Earthquake Engineering and Earth Sciences etc.

2.4 Model Room
The Department has a well-equipped model room with models and charts showing different aspects of several important water resources project including layout of works, structural details, construction facilities, etc. Working models of tunneling operations and some major construction equipments also form part of the model room.

2.5 Class Rooms/Lectures Theater and Seminar Rooms
The department has spacious and well-ventilated classrooms and lecture theater for regular classes. These rooms are well equipped with overhead projector, multimedia projection etc. The seminar room is air-conditioned and is also equipped with overhead projector & multimedia projection system.

2.6 Computer Laboratory
The Department has a computer laboratory with adequate facilities. The computer laboratory is being used for imparting education and development and use of various software for analysis of water resources problems. In addition to the departmental computer laboratory the computer centre of the IIT Roorkee is equipped with high end technical equipments like Param 10000 and IBM/6000, Alpha Server, SGI Server and many other Servers, along with large number of PCs and six laboratories which include Linux and Unix labs. Internal access is available from 8 A.M. to 11 P.M. on all the 7 days in week.

2.7 Lodging and Boarding
The Khosla International House (KIH), its Azad Wing and A. N. Khosla Bhawan provide non-AC accommodation (with attached bath room and a balcony) for the sponsored married officer trainees of this department. Some rooms are provided with kitchenette. A common mess in the KIH (formerly known as Asian African Hostel) caters Indian and Continental cuisine.

2.8 Other Facilities
The facility of PG students club, sports complex, swimming pool, and cinema of the IIT Roorkee can be availed by the trainee officers. Facilities of a well-equipped Hospital, Dairy, Bakery and a Cooperative Consumers' Store are available in the campus. A post office as well as the branches of State Bank of India & Punjab National Bank is also located within the campus. Computerized centre for reservation of railway journey is available in the campus.

2.9 Demonstration Farm
A new demonstration farm for research work related to soil-water-plant relationship studies, various methods of irrigation etc is developed.
3.1 General
Academic programs, research and consultancy services offered at this Department are governed by rules and regulations of the Institute which are reviewed and modified from time to time to keep pace with changes in the field of Water Resources Development. Brief information about present status is given below:

3.2 Academic Programmes
The Department offers broad based programmes of education and training in all aspects of Water Resources Development and Irrigation Water Management to in-service engineers and professionals having at least two years job experience. P.G. Training Certificate/P.G. Diploma/M.Tech. Degree programmes in following areas are available in the department.

- P.G.Training/P.G.Diploma/M.Tech. Water Resources Development (For Civil, Electrical and Mechanical Engineers)
- P.G.Training/P.G.Diploma/M.Tech. Irrigation Water Management (For Civil Engineers, Agricultural Engineers / Agricultural Scientists)
- Ph.D. Programmes

The students may opt for either the two-semester training/P.G. Diploma or four semesters M.Tech. Degree Programme or Ph.D Programme depending upon their eligibility as per Institute rules. The minimum qualification for admission to Ph.D. program in the department is as follows:

1. **Water Resources Development**
   B.E./B.Tech./M.E./M.Tech. or equivalent degree in Civil, Electrical, Mechanical & Agricultural Engineering.

2. **Irrigation Water Management**
   Master's degree in Agricultural Sciences/Social Sciences/Chemical Engineering/Biological Sciences/Environmental Sciences/Engineering/Natural Sciences with at least one paper of Mathematics at the graduate level or equivalent with a valid NET (CSIR/UGC/NET(LS)) or valid GATE and minimum CGPA of 6.50 on a 10 point scale or equivalent as determined by the institute where letter grades are awarded; or 60% marks where are awarded.

The announcement for Ph.D. programme is done separately at Institute level. The prospective candidates may look for the institute advertisement for the same.

The students admitted to M.Tech. Programmes have to carry out extensive research work in third and fourth semesters. A choice from several selective subjects is available for the course work. These subjects usually provide advanced level of knowledge, which can be applied to field problems. The subject of dissertation covers useful practical or theoretical problems and each student carries out his dissertation work under the guidance of one or more faculty members.

Some of the unique features of academic programmes of this department are as follows:

3.2.1 Visits to projects
Visits to projects are important aspect of academic programme. The visits are undertaken to different projects under construction or recently completed and to command area development works. Trainees study the choice of the type of dam and its design, river diversion arrangements, construction organization, degree of mechanization, etc. and of problems of water use and command area development. Lectures are delivered at the project sites by field engineers closely connected with project problems.

Discussions are oriented to bring out various problems faced on the field and their solutions. In order to make the training more effective visits have been grouped into two parts namely, (i) Observational tours and (ii) Study tours.

Each student is required to submit a report showing an objective appraisal of the projects visited. These reports are examined and assessed by the faculty accompanying the tours. A viva-voce examination of the students is also conducted before final assessment.

3.2.2 Diagnostic analysis
The students admitted to Irrigation Water Management course are required to carry out diagnostic analysis of a canal system. The study involves site visit for evaluation of main canal system, on-farm system, cropping pattern and socio-
economic aspects. This important part of training involves interdisciplinary study and exposes students to the field problems of irrigated agriculture. The students collect field data, analyze it and prepare a report. These reports are examined and assessed by the faculty guiding the analysis. A viva-voce examination of the students is also conducted before final assessment.

3.3 Short Term Training Programmes

The department has also been offering special short-term training courses in Water Resources Development and Irrigation Water Management for the benefit of in-service engineers from time to time. The department has organized several special short-term courses at the request of foreign and Indian Governments for training engineers, agriculturists and administrators in specialized fields. These include courses on (i) Ground Water Management for the officials of Govt. of Indonesia, (ii) Design and Operation of Barrage for engineers from Philippines, (iii) Water Supply Technology' for engineers from Zimbabwe (iv) Construction Management Through Systems Techniques for Engineers from Bangladesh, and (v) Irrigation Agronomy & Extension for engineers & Agronomists from Ethiopia etc.

Some short courses were also organized jointly with Asian Institute of Technology (AIT), Bangkok. The department has also organized short-term courses for training senior level executives and administrators in development and administration under the sponsorship of the Training Division of the Department of Personnel and Administrative Reforms, Government of India.

3.4 Research Projects and Consultancy Activities

In addition to research activities through M.Tech and Ph.D. Dissertations, the Department is actively engaged in sponsored research projects. The Department also renders useful technical service to various organizations and helps in solving complex field problems through consultancy and research projects sponsored by national and international organizations of repute like Ministry of Water Resources (MOWR), Indian Space Research Organization (ISRO), Department of Science and Technology (DST), Government of India and Hydro Coop Paris. There has been a considerable expansion in the research and consultancy activities in the department in recent years.
4.0 ADMISSION AND FELLOWSHIP

4.1 General

Admission and Fellowship of the sponsored candidates is governed by rules and regulations of the Institute and Government of India, which are reviewed and modified from time to time. Brief information about present status of eligibility requirements for admission in various courses run by this Department and obtaining fellowship are given below:

4.2 Categories of Officer Trainees and Students

The P.G. Diploma/M.Tech. Programme in Water Resources Development (for Civil / Electrical / Mechanical engineers) will have a total intake of 50 students with a maximum of 10 each from Mechanical Engineering and Electrical Engineering backgrounds, while remaining 30 seats are earmarked for those having Civil Engineering background. P.G./M.Tech. Programme in Irrigation Water Management (for Civil / Agricultural engineers / Agricultural Scientists) will have a total intake of 20 students. In addition, twelve (12) seats in WRD and three seats (3) in IWM are filled through GATE qualified Indians.

For the purpose of admission and award of scholarships the officer trainees are grouped under five categories as given in the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Group of Officers/Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Officer trainees sponsored by Indian or foreign governments whose total expenses (including pay and allowances, tour expenses, etc.) are borne by the sponsoring government or met under some aid programmes.</td>
</tr>
<tr>
<td>II</td>
<td>Officer trainees sponsored by industry and public/private enterprises in India whose expenses are fully met by their sponsors as in category I.</td>
</tr>
<tr>
<td>III</td>
<td>Government nominees from India on study leave on full pay or on half pay but not entitled to any other payments from their employers.</td>
</tr>
<tr>
<td>IV</td>
<td>Government nominee on leave of a kind other than study leave.</td>
</tr>
<tr>
<td>V</td>
<td>Students admitted through GATE (only fifteen seats).</td>
</tr>
</tbody>
</table>

4.2.1 Eligibility for Admission

Eligibility criteria for admission to various programmes are given below:

<table>
<thead>
<tr>
<th>Programme</th>
<th>Eligibility Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.G. Dip. / M.Tech Water Resources Development</td>
<td>Bachelor's Degree in Civil/Electrical/Mechanical/Electronics &amp; Tele-Communication Engineering or its equivalent.</td>
</tr>
<tr>
<td>P.G. Dip. / M.Tech Irrigation Water Management</td>
<td>Bachelor's Degree in Civil Engg. or equivalent /Agricultural Engineering or its equivalent or M.Sc. Agriculture in Agronomy, Soil Science, Agro meteorology with mathematics as one of the paper at the level of B.Sc./B.Sc. Agriculture.</td>
</tr>
</tbody>
</table>

Experience (For sponsored Candidate) As per enclosed Appendix - I

Notes:

Minimum Marks For General/OBC category candidates minimum 60 % or CGPA 6.00 on 10 point scale marks or equivalent grade is required.

For SC/ST/PD (Person with Disability) candidates' minimum 55% or CGPA 5.5 on 10 point scale marks or equivalent grade is required.

Training The department also offers 12 months training programme for sponsored candidates having less than 60% marks in the qualifying examination.

Equivalence/Recognition Equivalent qualification of Bachelor's degree in engineering shall be considered if found acceptable by the equivalence committee of the Institute.

Educational Institutions of India should be recognized by All India Council for Technical Education (AICTE).

QIP A few candidates may be admitted under Quality Improvement Programme (QIP) for which aspirants may contact the Coordinator (QIP) Indian Institute of Technology Roorkee, Roorkee 247667.

NOTE : The candidates working in Government/Semi government/PSU organization ONLY are eligible to apply through this information brochure.
4.3 Procedure for Admission and Grant of Scholarship

Applications for admission must reach the Department preferably by 30 June 2016 positively so that suitability for selection is notified by 1st week of July 2016. Candidates are advised to send their application well before the last date.

The estimated expenses for the two semesters PG Diploma and four semesters M.Tech. Degree programmes are given in Appendix -III.

4.3.1 Indian Candidates

Applications should be submitted in the prescribed form (Appendix-I) completed in all respects and duly endorsed by the employing government or organization. No scholarship is available for sponsored Indian candidates. However, there should be a certificate of financial guarantee from the sponsoring government or organization for meeting all their expenses and allowances during their academic degree programmes.

4.3.2 Foreign Candidates

The procedure for obtaining various scholarship/fellowship is described below:

(a) Government of India Scholarship/ Fellowship

The application of candidates sponsored by foreign governments for admission and for grant of scholarship/ fellowship by Govt. of India should be sent to the various Ministries of the government of India as indicated below:

For ITEC and for SCAAP Awards applications should be submitted in the prescribed form given in (Appendix-I) and sent through Embassies/Missions of India to The Ministry of External Affairs, Technical Cooperation Division, B-Wing, Jawaharlal Nehru Bhawan, 23-D Janpath, New Delhi - 110011 India

For TCS (Colombo Plan), applications in Form A2 and A3 (obtainable from Embassies/Missions of India in the countries of the candidates) should also be sent through Embassies/Missions of India to The Ministry of External Affairs, Technical Cooperation Division, B-Wing, Jawaharlal Nehru Bhawan, 23-D Janpath, New Delhi - 110011 India, alongwith application in the form in (Appendix-I). The Duration of fellowship shall be (one year/two year) as per policy of Government of India on date.

(b) United Nations/ESCAP Fellowship

Applications of candidates for admission and grant of United Nations/ESCAP (Economic and Social Commission for Asia and the Pacific) fellowships should be made in the prescribed form (UN/ESCAP) and forwarded in accordance with the procedure prescribed by the government of the applicants' country to the United National Headquarters, New York, or ESCAP, Bangkok as the case may be through the Resident Representative of his country under notification to The Prof. & Head, Department of Water Resources Development & Management, Indian Institute of Technology Roorkee, Roorkee 247667, India and to the Resident Representative, United Nations Development Programme, 55, Lodi Estate, New Delhi 110003, India.

(c) Commonwealth Scholarship

Applications of candidates from Commonwealth countries for admission and grant of scholarship under the Commonwealth Fund of Technical Cooperation should be made in the prescribed form (Appendix-I) and forwarded through the Embassies/Missions of India to the Director, Fellowships and Training Programme, Commonwealth Fund for Technical cooperation, Commonwealth Secretariat, Marlborough House, Pall Mall, London SW 1Y 5HX, with a copy to the Prof. & Head, Water Resources Development and Management, Indian Institute of Technology Roorkee, Roorkee 247667 India.

(d) Government Sponsored

Applications of candidates sponsored by foreign governments at their own cost may be made in the prescribed form (Appendix-I) and forwarded through the Embassies/Missions of India to the Prof. & Head, Department of Water Resources Development & Management, Indian Institute of Technology Roorkee 247 667, India with a copy to The Ministry of External Affairs, Economic Division, Government of India, Akbar Bhawan, Chanakyapuri, New Delhi 110021, India.

However, in this case the charges to be paid shall be intimated separately on request.

4.4 HIV Test

The Govt. of India has made test for HIV compulsory for all Foreign Students coming to India. It is therefore desired that every Foreign Trainee (Scholarship holder or Self Financing) coming to India should get themselves checked for HIV before leaving his home country, irrespective of the fact that he will be subjected to HIV test after joining the program at this department.

4.5 VISA Regulations

Foreign students intending to come to India for studies whether on self-financing basis or on Govt. of India scholarships, are required to get STUDENT'S VISA from Indian missions abroad. For students on Govt. of India scholarships, respective Indian missions are instructed by ICCR to grant regular students Visa once their admissions in Indian Universities are confirmed. Students not having firm letters of admission from universities etc., will be issued Provisional Students Visa by the Indian missions abroad on the basis of provisional admission certificate issued by university/recognized college or educational institution in India. Such Provisional Students' Visa will be valid for a period of 3 months and no extension of Provisional Students Visa will be allowed. Change of Purpose' of visit of foreign trainees to India is not allowed once they reach India. To avoid this situation, all foreign students on self-financing basis are requested to obtain regular students' visa from Indian Missions abroad by producing confirmed letter of acceptance/admission certificate from the University/Institutions.
5.0 CURRICULUM AND PERFORMANCE EVALUATION

5.1 General

Curriculum and Performance Evaluation is governed by rules and regulations of the Institute, which are reviewed and modified from time to time. Brief information about present status of Curriculum and Performance Evaluation in various course run by this Department are given below:

5.2 Curriculum

Postgraduate education demands the right kind of ambience, a good infrastructure, an acclaimed and dedicated faculty and considerable flexibility in the course structure. IIT Roorkee is the institute, which provides the above ingredients in abundance. Every course has been assigned certain number of credits depending upon the workload it involves. The performance of the candidate is continuously evaluated to motivate him to improve his/her performance throughout the duration of programme and "A" letter grade is awarded on the completion of the course. The course structure has enough flexibility and allows a student to progress at an optimum pace, commensurate with his intellectual quotient and convenience.

5.2.1 Teaching scheme

The course structures of the two academic Programmes provide sufficient flexibility for specialization in (i) Water Resources Development (for civil / electrical / mechanical engineers) (ii) Irrigation Water Management (for civil /agricultural engineers / agricultural scientists). The academic curriculum for Master of Technology/PG Diploma is given in Tables 1 & 2.

5.2.2 Credits (Crs) and weekly contact Hours

Each course (subject) has a number of credits, which depend on the academic load and weekly contact hours for Lectures (L), Tutorial (T) and Practical (P). One credit is normally assigned to one hour of lecture or two hours of tutorial or practical per week and distribution is expressed as Crs (L-T-P). The course System Design Techniques (WR-501) is common course for both the academic programme.
Table: 1  Academic Curriculum for Master of Technology / P.G. Diploma in
WATER RESOURCES DEVELOPMENT (WRD)

<table>
<thead>
<tr>
<th>S. No</th>
<th>SUBJECT CODE</th>
<th>COURSE TITLE</th>
<th>Teaching Scheme</th>
<th>Subject Area</th>
<th>CONTACT HOURS PER WEEK</th>
<th>EXAM. DURATION (Hrs.)</th>
<th>Relative Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L  T  P Theory Practical</td>
<td>CWS  PRS  MTE  ETE  P &amp; E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st YEAR</td>
<td>I SEMESTER (AUTUMN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>WR-501</td>
<td>System Design Techniques</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>Program Core Course 1</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Program Core Course 2</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Program Core Course 3</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II SEMESTER (SPRING)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>WR-505</td>
<td>Preparation of Water Resources Project Report</td>
<td>PCC</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5.</td>
<td>Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>WR-700</td>
<td>Seminar</td>
<td>SEM</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: P.G. Diploma course in WRD shall be of ONE YEAR duration comprising of semesters I and II only, with a minimum credits of 40 0

2nd YEAR | III SEMESTER (AUTUMN) |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. WR-701A</td>
<td>Dissertation Stage I</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* to be continued and grade to be awarded in the next semester

IV SEMESTER (SPRING)

| 1. | WR-701B | Dissertation (continued from 3rd Semester) | DIS | 18 | - | - | - | - | - | - | - | 60 | |
| | | | | | | | | | | | | | Sub Total 18 |

Total 70

PROGRAMME CORE SUBJECTS

For Civil Background

| 1. | WR-502 | Design of Water Resources Structures | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 2. | WR-503 | Water Resources Planning and Management | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 3. | WR-504 | Applied Hydrology | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |

For Electrical Background

| 1. | WR-531 | Hydro Generating Equipment | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 2. | WR-532 | Hydropower System Planning | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 3. | WR-533 | Power System Protection Application | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |

For Mechanical Background

<p>| 1. | WR-532 | Hydropower System Planning | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 2. | WR-551 | Design of Hydro Mechanical Equipment | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |
| 3. | WR-552 | Construction Planning and Management | PCC | 4 | 3 | 1 | - | 3 | - | 25 | - | 25 | 50 | - | |</p>
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Time</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR-511</td>
<td>Geotechnical Engineering</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-512</td>
<td>Hydropower and Appurtenant Works</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-513</td>
<td>Earth and Rockfill Dams</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-514</td>
<td>Masonry and Concrete Dams</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-515</td>
<td>Irrigation Structures</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-516</td>
<td>Rural and Urban Water Supply</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-517</td>
<td>River Engineering</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-518</td>
<td>Finite Element Methods</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-519</td>
<td>Water Resources System Reliability</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-520</td>
<td>Environmental Impact Assessment of Water Resource Projects</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-521</td>
<td>Groundwater Hydrology</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-522</td>
<td>Climate Change and Water Resources</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-534</td>
<td>Substation and Transmission line Design</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-535</td>
<td>Installation Maintenance and Testing of Hydro Generating Equipment</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-536</td>
<td>Maintenance Management in Power Plants</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-537</td>
<td>Power System Management</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-538</td>
<td>Electrical Design of Hydro Power Station</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-539</td>
<td>Power System Operation and Control</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-540</td>
<td>Control and Instrumentation of Hydro Power Plant</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-541</td>
<td>Power System Analysis</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-542</td>
<td>Power System Reliability</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-543</td>
<td>Insulating Systems</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-544</td>
<td>Planning and Design of Small Hydro Power Schemes</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-545</td>
<td>Power Electronics Controlled Hydro-Electric Systems</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-546</td>
<td>Modelling and Simulation of Hydro-Electric Energy Systems</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-547</td>
<td>Synchronous and Asynchronous Generators Laboratory</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-548</td>
<td>Power Electronics Laboratory</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-549</td>
<td>Control and Instrumentation Laboratory</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-553</td>
<td>Design of Construction Job Facilities</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-554</td>
<td>Construction Plant Machinery</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-555</td>
<td>Air Conditioning and Ventilation</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-556</td>
<td>Construction Techniques</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-572</td>
<td>Soil and Agronomy</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-580</td>
<td>Renewable Energy System Technology</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-581</td>
<td>Water Quality Monitoring and Modeling</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-583</td>
<td>Remote Sensing and GIS Applications in Agriculture</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-586</td>
<td>Groundwater Development and Management</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>WR-587</td>
<td>Watershed Development and Management</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
PROGRAM CORE COURSES (WRD)

Civil Background

WR-501 System Design Techniques
System concepts: Boundary, environment, input, output and constraints; Open and closed systems; System modeling, water resources systems, issues in system application; Operation research approach to system analysis.
Linear programming: Model formulation, graphical method, simplex procedure- two phase, big-M, dual simplex, primal-dual simplex, modified simplex procedures; Upper bounded solutions, sensitivity analysis.
Transportation problems: Basic feasible solution techniques, testing for optimal solution; Integer and mixed integer problems, assignment problems, applications for efficient water resources management.
Non linear programming (NLP): Separable and convex programming problems, quadratic programming, unconstrained and constrained NLP problems, chance constrained programming, method of calculus, search techniques.
Dynamic programming: Optimality principle, deterministic and stochastic dynamic programming, application to water resources problems.
Decision making: Value and utility concepts, goal programming, decision theory and decision trees, decision making under risk and uncertainty, theory of games; Multi criteria decision making- distance based and compromise techniques.

WR-502 Design of Water Resources Structures
Design of hydraulic structures on permeable foundation including weir and barrage; determination of afflux and discharge intensity; waterway and looseness factor; stilling basin level and length; uplift pressures and exit gradient; floor thickness and protection works.
Gravity dams - general features; forces acting on gravity dam; galleries and their functions; stability analysis; roller compacted RCC dams.
Earth dams- homogeneous and zoned sections; filter design and stability analysis.
Spillways-layout and design of various types of spillways; design of energy dissipaters.
Intake Structures-trash racks and their cleaning and handling devices; stoplog arrangements; intake entrance; aeration vent; gate control.
Tunnels-classification; rock cover; hydraulic design and supporting systems; concrete lining; portals and plugs; underground cavities.
Gates- various types of gates for barrages; spillways; intakes; sluices; structural design considerations for vertical lift and radial gates.
Hydro power-function; classification and main components (penstocks, surge tanks, hydro turbines, etc.) of hydro power stations.

WR-503 Water Resources Planning and Management
Objectives of water resource development; needs and opportunities; societal goals.
Spatial and temporal characteristics of water resources; constraints for its development like non-reversibility; planning region and horizon.
Financial analysis of water resources projects; allocation of cost of multipurpose projects; repayment of cost.
Demand for drinking water; irrigation, hydropower; navigational; planning for flood control.
Characteristics and functions of reservoir; reservoir sedimentation; conservation storage; conflict among uses, Reservoir operation studies - effect on river regime; long term simulation; reliability; resiliency and vulnerability assessment.
Ground water evaluation; conjunctive use of surface and ground water.
Discounting techniques; benefit cost parameters; estimation of benefits and costs; appraisal criteria; social benefit cost analysis.
Basin planning; inter-basin transfer of water.
Environmental impacts assessment guidelines and case studies.

WR-504 Applied Hydrology
Introduction: Hydrologic design requirements, hydrologic cycle, classification of processes and models
Hydrologic Data: Observation and collection; Processing - supplementing, consistency checking, corrections and presentation
Frequency Analysis: Probability distributions, statistical analysis, return period of flood and storm, outliers, regional flood frequency, confidence interval and goodness of fit
Rainfall runoff models: Empirical, conceptual and physical; Unit hydrograph; Decisions with inadequate hydrologic data
Hydrologic Design: Design criteria, dependable yield, design storm, design flood estimation, reservoir and channel routing
Flood Forecasting: Travel time, correlation, telemetry, gage and discharge forecasting
Elements of Groundwater Hydrology: Ground water recharge, ground water balance, aquifer properties
Electrical Background

WR-531 Hydro Generating Equipment

Characteristics and specification of hydro-generators; constructional details- bearings and bearing location; brakes and jacks for hydro-generators.
Cooling and ventilation- insulation and temperature limits; fire protection; electrical and mechanical tests; operating limits of hydro generators.
Unit transformer and bus duct- excitation system and voltage regulators; excitation requirement; sources; drives; automatic excitation control equipment; typical schemes.
Different types of turbines with their constructional details including reversible pump turbines, tubular, bulb and straflow turbines their characteristics and selection.
Cavitation and Turbine setting; testing of water turbines at manufacturer's works and at site, model tests.
Mechanical governors, electro hydraulic governors, digital governors, pressurized oil system for hydro-turbines.

WR-532 Hydropower System Planning

Sources of energy and status of hydropower-global power scenario; hydropower policies of various countries; principles of hydropower development; components of a hydropower scheme, types of hydro power plants – run-of-river; valley dam; diversion canal plants; high head plants; pumped storage schemes, etc.; power house planning for surface and sub-surface hydropower plants.
Rainfall–runoff relationships, flow measurement in rivers and streams, hydrograph analysis, design flood estimation, flow and power duration curves, power potential estimation, prediction of firm and secondary power, load curve, load, capacity, utilization and diversity factors, determination of installed capacity.
Diversion structures, different types of dams and their suitability, site selection, intakes, spillways, and energy dissipaters.
Water conveyance through penstocks-design criteria and economic diameter of penstock; conduit valves; water hammer.
Economics and financial analysis of hydropower projects -time value of money; discount rate; single payment interest factors; uniform series factors; capital recovery factor;effect of inflation; depreciation; return on investment, Benefit cost analysis-Internal rate of return; levllisation; generation cost; energy pricing and tariff principles.

WR-533 Power System Protection Applications

Principles of power system protection application
Current and voltage transformers characteristics and application
Electro-mechanical, static and microprocessor-based relays
Electrical protection of generators and generator transformers
Protection of transformers for electrical and incipient faults
Different types of electrical protection applicable to bus zones
Protection of transmission lines by over current, pilot-wire, distance and with carrier application
Protection of single phase and three phase motors- induction and synchronous types; Protection of reactors, capacitor banks and industrial power systems

Mechanical Background

WR-551 Design of Hydro Mechanical Equipment

Different types of hydro turbines with their constructional details including reversible pump turbines, tubular, bulb and straflow turbines their characteristics and selection.
Pumps for pumping water-characteristics; selection of size and type and constructional features .
Gates for different types of spillways; barrages; under sluice and dam outlet, their general features and comparative merits; structural design of radial and vertical lift gates.
Different types of hoists for gates- design of rope drum hoist; different types of valves and their selection.
Different types of penstock layout- hydraulic and structural design of penstocks.
Fabrication, handling, alignment, erection and support arrangement, painting and testing of penstocks.

WR-552 Construction Planning and Management

Problems in planning and control of present day construction- applications of System Design Techniques; advantages and limitations of systems approach.
Linear Programming applications like transportation and assignment models.
Waiting line models for construction planning and management
Inventory Models and Replacement Models in construction planning and management.
Network systems in project planning; use of CPM in planning scheduling and controlling of construction projects.
Network development and monitoring of construction projects.
Network crashing and time-cost trade-off in construction planning and management.
Use of different techniques for resource allocation and leveling in construction planning and management.
Use of PERT in construction planning - PERT analysis; use of dynamic programming in project evaluation and construction planning and management.

PROGRAMME ELECTIVES

WR-511 Geotechnical Engineering
Composition and classification of soil: Importance of soil mechanics in water resources applications; Textural properties and their determination; Identification and classification of soils.
Seepage analysis: Flow net; Theory of seepage and analysis; Quick-sand phenomenon and seepage forces.
Compressibility and consolidation: Compressibility of soil; Terzaghi’s theory of consolidation; Secondary consolidation.
Shear strength of soils: Friction; Mohr's circle; Strength theories for soils; Pore pressure parameters; Shearing characteristics of sand and clay.
Stability of earth slopes: Earth pressures; Stability of retaining walls; Bearing capacity; settlement analysis.
Foundation—Types of shallow foundation, foundation on nonuniform soils; Deep foundation; Design and construction of pile foundation.
Engineering geology: Classifications and properties of rocks, folds, faults, joints; Unconformities and their bearing on engineering structures; Geophysical and geological explorations for various engineering projects.
Rock mechanics: Theories of failure and strength of rock masses; Geophysical and geological explorations for various engineering projects.

WR-512 Hydropower and Appurtenant Works
Surface hydro power stations: Basic functional features and typical general arrangements; Classification of surface power houses, vertical sub-divisions, type of super structures; Overall layout, preliminary dimensions of various components, main floor levels.
Arrangement at various floors: Details of auxiliary equipment, arrangement at various floors, joints, collection of data, design and indexing of loads.
Stability analysis of powerhouse: Stability of substructures, intermediate structures and superstructures.
Underground power stations: Number and size of cavities, their location and alignment, auxiliary equipments and their arrangement, supporting arrangements for roof and sides, design considerations, design of gantry girder column.
Tunnels and shafts: High head pressure tunnels and shafts, design considerations, design of concrete lining and steel liner, pre-stressed concrete lining, grouting and drainage.
Surge tanks: Characteristics and suitability of various types of surge tanks like simple, restricted orifice and differential types, criteria for design and stability, hydraulic design.
Penstocks: Water hammer phenomenon, velocity and pressure waves, estimation of over-pressures by arithmetic integration and by use of charts and curves, effects of over pressure on governing of turbines; Forces acting on penstock pipe lines and preliminary design of steel penstocks, fabrication and testing of penstocks; Design of anchors, piers and saddles.
Switchyard: Equipments in the switchyard and their layout, design of foundation.

WR-513 Earth and Rock Fill Dam
Materials properties of soils: Pore pressure parameters; Hilf Bishop method; Shear strength of soils; Mohr Coulomb failure criterion; Factors contributing to slope failure.
Design criteria: Types of earth dams; Design considerations— Freeboard calculations, dam section, upstream slope protection; Design considerations in earthquake regions; Filter design; Causes of damage and failure, typical case studies.
Seepage control: Control of seepage through earth dam on pervious soil foundation and on impervious base; Cutoff trench; Sheet pile; Alluvial grouting; Slurry trench; Horizontal upstream blanket; Relief wells; Loading berm; Treatment of rock foundations and grouting.
Stability analysis: Total and effective stress methods of analysis; Standard method of slices, Simplified Bishop method; Wedge method; Stability conditions during construction, full reservoir and reservoir drawdown.
Analysis of dam: Introduction to finite element method (FEM); FEM analysis of dams; Nonlinearity in soils.
Rockfill dam: Considerations favouring choice of a rockfill dam; Principles of design; Selection of materials; Stability analysis by wedge method, Different types of impervious cores and their locations; Different types of face members; Settlement in rock fill dams, Procedure for placement and compaction of rock fill.
Instrumentation in earth dams: Measurements of deformations, pore pressures; Quality control; Foundation preparation and
treatment; Quality control of materials and control of moisture, laying and compaction; Tests for quality control; Diversion during construction.

WR-514 Masonry and Concrete Dams
Introduction: Selection of site for different types of dams, selection of materials, layout of works; Properties of concrete as related to dams.
Gravity Dams: Forces acting on a dam including uplift and wave forces; Design criteria for stability; Determination of dam profile; Computation of stresses by gravity analysis; Elastic analysis by finite element method and structural modelling techniques; Seismic design and analysis; Determination of internal stresses.
Foundation treatment: Preparation of foundation including consolidation; Curtain grouting and treatment of faults and weak zones; Foundation cutoffs and drainage arrangements; Layout and location of spillway; Powerhouse and other appurtenances.
Stressed and their management: Stresses around openings; Design of galleries in dams; Temperature stresses and methods of temperature control; Joints and seals.
Instrumentation and maintenance aspects: Instrumentation and analysis of data; Deterioration of concrete in dams and remedial measures.
Hollow and buttress dams: Principles of hollow gravity dams; Stability criteria and determination of internal stresses.
Arch dams: Classification, principles of layout and factors affecting layout; Theories for arch dam analysis.

WR-515 Irrigation Structures
Site selection and investigations for diversion works; Hydraulics of flow over weirs/under sluices; Hydraulic jump, seepage theory, Khosla theory, scour depth estimation, critical exit gradient.
Design flood estimation; Types and design of energy dissipaters; protection works, transitions.
Components of barrage- waterway, undersluice/weir, glacis, stilling basin and appurtenance works, cutoff, u/s and d/s protection works; Hydraulic design of barrage; Head regulator; Cross regulator.
Types of cross drainage works; Design aspects of aqueducts, siphon aqueducts, super-passage, siphon.
Concept of sediment removal, fall velocity, difference between sediment exclusion and ejection devices, design aspects of sediment excluder and sediment ejector.
Types of loads and their combinations; Structural design of raft foundation, piers, abutments, and retaining walls.

WR-516 Rural and Urban Water Supply
Introduction: Planning and preparation of water supply schemes for rural and urban areas; Issues in water supply for hilly and coastal regions, regional and national perspective; Water pricing.
Water Supply Sources: Surface and sub-surface, selection, protection, contamination protection zone, estimating potential yield and sustainability; Design of wells.
Water Quality: Drinking water quality parameters, comparison of international and national codes, physical and chemical treatment processes, disinfection and appropriate technologies for water treatment.
Components of Intake Works: Sizing water mains, pumps for water supply, pumping station, pipe appurtenances, pipe materials, laying of pipes, design of water distribution network and allied works.
Water Distribution Networks: Flow through pipes, equivalent pipes, solving pipe network flow problems, use of computer software for network analysis.

WR-517 River Engineering
Sediment Transport Processes: Incipient motion of sediment particles; Regimes of flow; Resistance to flow and velocity distribution in alluvial streams; transport of bed, suspended and total load.
River Morphology: Plan form variations and river channel pattern; Meandering and braided stream characteristics; River equilibrium, river dynamics and adjustments to stream power.
River Training Techniques: Principles of stabilisation and rectification of rivers, river bank stability analysis, spur / groyne, stream bank armouring, guide banks, submerged vanes, porcupine and jack jetty systems, gabions; Bandalling, surface and bottom panels.
Inland Navigation Channel Development: Fairway dimensions and maintenance, canalization, navigation locks and terminals.
River Models: Mathematical modelling - types, mathematical formulation, numerical procedures, calibration and validation; Scale modelling – types, principles of similitude and dimensional analysis, model verification, limitations.
Flood Management and Remote Sensing Applications: Flood control planning, flood plain zoning and other non – structural measures, use of satellite imageries and topo sheets for DEM generation for flood plain zone mapping.
WR-518 Finite Element Methods
Introduction: Finite difference method (FDM), finite element method (FEM), advantages of FEM over FDM and matrix algebra.
Basics of FEM: Steps, formulation of element equations, shape functions for triangular elements, load and strain displacements, stress strain relations, variational principles.
Weighted Residual Methods: Collocation, sub-domain, Galerkin's and least square.
Shape Functions: Linear elements, element equations, iso-parametric elements, Hermite polynomial, Jacobian matrix, numerical integration, two dimensional, Lagrangian, triangular and trapezoidal elements.
Solution Techniques: Axisymmetric problems - element equations, stiffness matrix, boundary conditions; Direct and Iterative methods, band solver and frontal solution techniques.
Applications of FEM: Heat flow problems in one, two and three dimensions; Beams and trusses; Dams and seepage problems.
Software Applications: Case studies, data preparation, processing and result reporting for field problems.

WR-519 Water Resources System Reliability
Introduction: Concepts of perceived and statistical risk, role of risk assessment in modern technological, social, and environmental context.
Risk Assessment: Techniques, application of probabilistic and Markov models, uncertainty in risk assessment, decision-making under uncertainty and risk.
Fuzzy Theory: Introduction, applications in risk analysis.
Reliability concepts: Bath tub curve, hazard rate, failure density functions, repairable and non-repairable systems, mean time to failure (MTTF), mean time between failures (MTBF), mean time to repair (MTTR).
Reliability Estimation: Useful life of components, reliability estimation under extreme value distributions.
Performance Evaluation: Reliability, resiliency, and vulnerability assessment; Case studies.

WR-520 Environmental Impact Assessment of Water Resources Projects
Introduction: Human concern; Need for environmental impact assessment (EIA); Requirements and levels of EIA; Potential impacts of water resource development projects.
EIA Procedure: Screening, baseline data, scoping, terms of reference (TOR).
Environmental Clearance: Guidelines, acts and legislations, codes and country practices.
Environmental flow: River as habitat, downstream direct and indirect uses, criteria and methods of assessment.
Soil and Water Quality Management: Effect of project development on soil and water quality, water logging, soil salinity, and contamination, remedial measures.
Rehabilitation: Submergence effects, rehabilitation guidelines, planning, and procedures.
Monitoring: Parameters to be monitored, frequency of monitoring, reporting procedures.
Remote Sensing and GIS Applications: Monitoring of land use changes, digital elevation model (DEM), assessment of land degradation, catchment area treatment plan.
Simulation Exercises and Case Studies.

WR-521 Groundwater Hydrology
Introduction: Occurrence of groundwater sources; Groundwater bearing formations; Classification of aquifers; Flow and storage characteristics of aquifer; Hydrologic budget.
Groundwater movement: Darcy's law; Hydraulic conductivity and its determination; Anisotropy and heterogeneity; Groundwater flow rates and directions, governing equations for groundwater flow; Analytical solutions, general flow equation; Unsteady flow.
Well hydraulics: Steady unidirectional and radial flow; Unsteady radial flow in confined and unconfined aquifers; Leaky aquifer; Determination of aquifer parameters; Pumping tests and analysis; Well flow near different boundaries; Multiple well systems; Interference of wells.
Groundwater wells: Types and features of each type of wells; Well development, yield test.
Groundwater quality: Indian and international standards; Pollution of groundwater and possible sources; Remedial and preventive measures.
Groundwater flow modeling: Need of groundwater flow models; numerical modeling, 2D and 3D groundwater flow models; MODLFOW and its application.
Conjunctive use planning: Planning of groundwater development; Conjunctive use models, constraints, application in water resources management.
Groundwater conservation: Regional groundwater budget; Resource assessment; Estimation of recharge; Artificial recharge; Rainwater harvesting.
WR-522 Climate Change and Water Resources
Introduction to atmospheric science: Earth, its atmospheric cycle and its relation with climate; Green house gas and climate change; Earth and green house effect; Past climate change; Lessons from history; Present and future climate changes.
Ecological effect on freshwater systems- surface water, ground water and glaciers; Agriculture; Marine environment; Causes, human dimension- impact of human settlement and infrastructure, environmental quality.
Analysis for climatic change assessment, statistical analysis of long-term meteorological and hydrological data; Trend analysis.
Available climatic models such as GCM; Hydrologic models such as SWAT and Mike11; Downscaling of GCM to regional/local scales.
Mitigation- capture of sequester carbon emissions, reducing global warming, renewable energy technologies, efficient use of energy.
Policy, laws, economics, benefits and costs of mitigating climate change, international cooperation.

WR-534 Substation and Transmission Line Design
Transmission system planning including selection of voltage, AC and DC transmission systems, number of circuits.
Travelling waves, lightning phenomenon, lightning and switching surges, surge wave shapes over voltages in power systems- types lightning, switching and temporary control of over voltage, statistical characteristics of over voltage; Flashover characteristics of rods gaps and insulators.
Characteristics of lightning arresters and protective devices, selection of lightning arresters, insulation coordination, location of protective devices, direct stroke protection, protection of transformers, surge protection of generators.
Electrical design of overhead lines, choice of conductor, voltage regulation, losses, charging KVA requirements; Surge impedance loading; Stability considerations; Corona and radio interference characteristics.
Survey of transmission lines, plotting of profiles, planning and locating line supports; Inductive coordination between power and communication lines; Series and shunt compensation.
Design of various HV and EHV substations, switching and busbar schemes, typical layouts, oil and compressed air systems.
Power transformers- specification, types, rating electrical characteristic, insulation temperature rise.
Circuit breakers- types, ratings, electrical characteristics

WR-535 Installation, Maintenance and Testing of Hydro Generating Equipment
Basic components of hydro turbines, pre-requisite for erection of hydro turbine, erection of under water parts, concreting of embedded parts, erection of internal parts for Francis, Kaplan, Deriaz and Pelton turbines (vertical type), erection precision.
Erection of vertical large generator.
Hydraulic model testing of hydro turbines and on-site testing.
Pre-commissioning and commissioning tests on generator.
Erection of large power transformers, commissioning tests and preventive maintenance tests of solid and liquid insulation, reconditioning and reclaiming methods of insulating oil.
Preventive maintenance testing of generator insulation.
Routine and preventive maintenance and capital maintenance of hydro turbines and generators.
Testing of protective relays, over current, impedance and directional relays.
Preventive maintenance and its scheduling, maintenance of records, record keeping and analysis.

WR-536 Maintenance Management in Power Plants
Importance of maintenance, objectives, functions, maintenance management strategies for hydro power stations and their organization.
Maintenance policies and planning- maintenance strategies and their advantages and disadvantages, planned maintenance procedure, advantage of planned maintenance, scientific maintenance, safety in maintenance.
Maintenance activities- optimal overhaul, repair or replacement policies for equipments subjected to breakdown, budgeting and control, production maintenance integration.
Replacement decisions- economic models, replacement policy, economics of preventive maintenance.
Maintainability and availability- economics of maintainability and reliability, maintainability increment, equipment availability.
Management information systems for maintenance.

WR-537 Power System Management
Management and its goals- management processes, managerial skills and performance, policy and objectives of a power utility; electricity industry and market- main concerns of electric utilities, performance of electric utilities, power sector changes.

Investment proposal- interest and compounding, measure of price- public and private perspective, internal rate of return and payback period.

Cost of generation, levelisation of cost of generation; Tariff for electricity- objectives, traditional approach, long-run marginal costs, general principles of tariff design.

Dynamic, spot and real time pricing strategy, bidding strategies.

Concepts and methods of demand side management (DSM)- load control, energy efficiency, load management, DSM planning, design, marketing, customer incentives.

Fundamentals of deregulation- privatization and deregulation, necessity for restructuring the power industry, necessity of unbundling of generation, transmission and distribution.

Components of restructured systems, independent system operators, functions and responsibilities, trading arrangements (pool, bilateral and multilateral), open access transmission system.

Different models of deregulation- Indian model, UK model, California model, Australian and New Zealand models, Japan model, Thailand model.

**WR-538 Electrical Design of Hydro Power Station**

Selection of turbine and generating equipment for conventional, small hydro and pumped storage stations.

Types of pumping schemes- sources of power for pumping, starting of reversible units, pumped storage plant operation in the system, economics, choice of site, choice of plant.

Design and dimensional parameters of the turbine and generators; Cavitation and turbine setting.

Planning and layout of electrical equipment in a conventional, small hydro and pumped storage stations- case studies; Turbine governing, speed and pressure regulation, relief valves, frequency control.

Auxiliary power supply system design and equipment, power and control cables and their ratings.

Auxiliary system design and equipment for DC system and batteries, lighting system, grounding system, control and annunciation system and internal communication system.

Auxiliary system design involving air conditioning and ventilation system, lubricating oil system, fire protection system, power house crane and drainage and dewatering systems.

**WR-539 Power System Operation and Control**

Modelling of generator, load, prime-mover, governor and excitation system.

Modelling of governor and excitation system.

Probabilistic methods for generation planning.

Unit commitment- spinning reserve, thermal unit constraint, hydro constraints and solution methods.

Long-term and short-term hydro-generation scheduling.

Hydro-thermal scheduling- problem formulation and solution.

Interchange evaluation- economy, capacity, diversity emergency power, inadvertent power exchange, energy banking.

Power pools- energy broker system, centralized economic dispatch of a power pool, allocating pool savings.

Power system security evaluation, factors affecting power system security, contingency analysis.

Power system state estimation- maximum likelihood weighted least squares estimation, detection and identification of bad data, application of power system state measurement.

**WR-540 Control and Instrumentation of Hydro Power Plant**

Essentials of measurement, implementation and scope of instrumentation; Performance characteristics, accuracy, response time, reliability and availability, types of equipment.

Measurement techniques and instruments for temperature, pressure, level, flow, speed, vibration, electric power and power factor measurement.

Strip-chart and X-Y recorders of galvanometric and servo types- magnetic recorder; FM recording technique; Indicating and display devices.

Control room instrumentation- design factors and validation, operator interface and ergonomics, computer based displays.

DC, AC pulse and digital telemetry, signal transmission media.

Automation schemes in hydro-electric power plants for start and stop operation.

Elements and functions of SCADA system, automatic controllers closed loop control; On-off, proportional, PI and PID controllers, pneumatic and electronic controllers, automatic controllers in hydro-electric plant.
WR-541  Power System Analysis
Complex power in balanced transmission lines, per unit system, constant impedance representation of the loads, three winding transformers, autotransformers, delta-wye and wye-delta transformations.
Disturbance of normal operating conditions, fault types and their analysis, symmetrical components, sequence networks balanced three phase faults at no load and full load, analysis of unbalanced faults, application of current limiting reactors.
Load flow analysis, Gauss iterative method, Gauss-Seidel iterative method and its applications; \( Y_{inv} \), application of acceleration factors, application of Gauss-Seidel method \( Z_{inv} \); Newton - Raphson method and its applications in rectangular coordinates and polar coordinates; Decoupled load flow method, fast decoupled load flow method, DC load flow method.
Linear models of the synchronous machine, steady-state equations and phasor diagrams, initial conditions for a multi-machine system, analog and digital simulation of synchronous machine.
Excitation systems- control configuration, response, state-space description, computer representation, typical system constants, effect of excitation on generator performance.
Speed governing, modeling of governing system for hydro turbines.
Modeling of hydraulic turbine prime movers, conduits, surge tanks and penstocks, hydraulic system equations, hydraulic system transfer function, block diagram for a hydro system.

WR-542  Power System Reliability
Basic probability theory, binomial distribution, Poisson distribution, normal distribution, adequacy and security evaluation.
Basic reliability concepts- general reliability function, exponential distribution, mean time to failure, series and parallel systems, Markov and continuous Markov processes, recursive techniques; Other Markov applications- simple series and parallel system models.
Component reliability- non-repairable components, hazard models, components with preventive maintenance, repairable components, ideal repair, ideal repair and preventive maintenance, repairable components, normal repair and preventive maintenance.
Static generating capacity reliability evaluation-capacity outage probability tables, the loss of load probability method, load forecast uncertainty, the loss of energy probability method, frequency and duration approach.
Spinning generating capacity reliability evaluation-spinning capacity evaluation, load forecast uncertainty, derated capacity levels.
Transmission system reliability evaluation-average interruption rate method, frequency and duration method, stormy and normal weather effects, Markov process approach, system studies.
Composite system reliability evaluation-service quality criterion, conditional probability approach, simple system application, two-plant single load systems, two-plant two load systems, networked system approach.
Interconnected system generating capacity reliability evaluation- probability array for two systems, loss of load approach, reliability evaluation in more than two systems, interconnection benefits.
Direct current transmission system reliability evaluation- system failure modes, loss of load approach, frequency and duration approach, Spare valve assessment, multiple bridge equivalents.
Assessment of reliability worth-interruption cost for commercial users, industrial users, residential users and interruption energy assessment rate.

WR-543  Insulating Systems
Electrical conduction of dielectrics, volume resistance, electrical conduction in metals, semi-conductors and dielectric, band theory of solids, ionic and molionic electrical conduction of dielectrics, electrical condition of gases, dependence of resistivity of dielectric on various factors, surface conduction of dielectrics.
Polarization of dielectrics, relationship between capacitance and resistance of an insulator, polar and non-polar dielectric, polarization, dependence of permittivity on various factors, electric fields in non-homogeneous dielectrics, mechanical forces in dielectric.
Dielectric losses, basic definitions and equations, dependence of tan delta on various factors, dielectric losses under non-sinusoidal voltage.
Breakdown of dielectrics, breakdown of gaseous, liquid, solid dielectrics.
Non-linear dielectrics, ferroelectrics, capacitors with a barrier layer, piezoelectrics; Properties of dielectrics, wetting thermal and radiation properties.
Insulation of power transformers, construction of the insulation of power transformers, transient processes in transformer windings, internal protection of transformers, testing of transformer insulation.
Insulation of high voltage rotating machines and its construction, puncture voltages of the insulation of rotating machines, methods of elimination of corona in the insulation of rotating machines, transient phenomena in windings of electrical machines, testing of the insulating systems.
Insulation of high voltage power cables, types and construction, oil fuel cables, testing of cable insulations, insulation of power
condensers, paper impregnated condenser insulation.
Preventive testing of insulation, measurement of tan delta and capacitance, partial discharges and methods of its detection, preventive testing of bushings, suspension and post insulators, preventive testing of transformer insulation, preventive testing of insulating rotating machines, preventive testing of cables with viscous impregnation.

WR-544 Planning and Design of Small Hydro Power Scheme
Small hydro definition and country status, government policy for renewable energy development including small hydro, basic components of a small hydro scheme
Hydrology, regional flow duration models, rainfall-runoff modeling for small catchments, flow duration, considerations for environmental flow
Planning and design of diversion, intake, desilting and water conductor system
Types of turbines for small hydro, their characteristics, construction and selection of turbine
Synchronous and induction generators–characteristic, specification and application
Power evacuation system, design, control systems
Planning and design of auxiliary systems–cooling water, drainage and dewatering, ventilation and lighting
Protection of synchronous and induction generators, protection of transformer and transformer feeder
Economic and financial analysis of small hydro projects
Case Studies–low, medium and high head small hydro projects

WR-545 Power Electronics Controlled Hydro-Electric Systems
Introduction, Interdisciplinary nature of power electronics, interconnection of renewable energy sources and energy storage, Power semiconductor devices: Diode, Thyristor, Triac, GTO, BJT, Power MOSFET, IGBT, SIT, IGCT, commutation, line commutated diode and thyristor rectifiers: single phase and three phase, practical limitations, application of line commutated rectifiers
Gate commutated inverters (DC to AC converter), single phase square wave inverter, single phase PWM inverter, three phase inverters, cycloconverters, AC voltage regulators.
Static excitation systems, Variable speed operation of electric generators (synchronous and asynchronous): Equivalent circuit, operation at the power grid, autonomous operation, electrical losses and efficiency, modeling of synchronous and squirrel cage and doubly-fed induction machines in d-q frame, static power converters for induction generators, vector control of machine-side and source-side converters.
Voltage, active power and reactive power control in variable speed hydro generators, parallel operation of induction generators, static capacitor exciter stand-alone induction generator for pumping applications, power control strategies for pumped storage system: load following and frequency droop control, power factor and displacement factor.
Electromagnetic compatibility: analysis of harmonic distortion, acceptable levels of distortion in main supply system, voltage and current in the machine side converters, methods of reducing harmonic voltages, protection of ac converters and generators, installation and commissioning of converters

WR-546 Modelling and Simulation of Hydro-Electric Energy Systems
Electromagnetic energy conversion modelling and analysis: Energy relationships - Energy in coupling fields - Interpretation of energy conversion, Steady state and dynamic performance of an electromechanical system
Modeling of converters: Modeling of back to back converters based on Two-Level VSC Topology used for synchronous and asynchronous generators in hydroelectric energy system, Pulse Generation of the Controlled Switches
Synchronous generator: Modeling of synchronous machine, excitation system, Simulation of developed model to study real and reactive power delivery, Abnormal operating conditions of synchronous generators
Squirrel cage induction generator: Modeling of Squirrel cage induction generator, Modeling of excitation system, Simulation of developed model to study real and reactive power under grid disturbances: voltage unbalance, voltage sag/swell
Doubly-Fed Induction Generator: Modeling of doubly fed induction generator steady state modelling dynamic modelling, Modeling of excitation system, Real and reactive power control of rotor circuit power converters, Doubly-Fed Induction Generator under grid disturbances

WR-547 Synchronous and Asynchronous generators Laboratory
Synchronous Generators -Stand-alone operation: Efficiency determination under part load operation, Voltage Regulation, Voltage and frequency control, Electronic load controller
Grid connected operation: Synchronization, Real and reactive power control, Analysis of harmonic distortion
Squirrel cage Induction generator: Stand-alone operation: Excitation capacitance calculation, No-load saturation current and voltage buildup, Load-voltage characteristics with different p.f loads, Effects of load voltage by inserting capacitor in series with load, Loss of residual magnetism, Generator under short circuit condition, Performance comparison of induction machine
working as motor & Generator: stator current, Magnetizing current, Power factor, Efficiency, Core losses, Air gap voltage.
Grid connected operation: Real and Reactive power control, Parallel operation of induction generator
Doubly fed induction machine (DFIM): Power and energy measurement: Operation at stator short circuit, operation at rotor short circuit, Startup transient during motoring mode, Active and reactive power control at motoring and generation modes, Equivalent circuit parameters
Adjustable speed operation of hydro generators: synchronous generator, squirrel cage generator and DFIM, Active and reactive power control at variable speed, Voltage and frequency control using PWM voltage fed converter and dSPACE controller
Measurements of harmonic distortions in machine side and grid side converters during variable speed operation.

WR-548 Power Electronics Laboratory

Exp.1 Characteristics of power electronic switches: DIAC, TRIAC, SCR, Power MOSFET and IGBT
Exp.2 Study of driver circuit: SCR, Power MOSFET, and IGBT
Exp.3 Study of PWM techniques (SPWM and SVPWM)
Exp.4 SCR based single phase rectifier: (i) Semi controlled, (ii) Fully controlled
Exp.5 SCR based three phase rectifier: (i) Semi controlled, (ii) Fully controlled
Exp.6 IGBT based three phase PWM rectifier
Exp.7 DC chopper circuits: Class A, B, C, D and E
Exp.8 IGBT based single phase voltage source Inverter
Exp.9 IGBT based three phase voltage source Inverter
Exp.10 IGBT based three phase four quadrant back-to-back converter
Exp.11 SCR based AC regulator: (i) Single phase, (ii) Three phase
Exp.12 Cycloconverter

WR-549 Control and Instrumentation Laboratory

Control of asynchronous machines used in hydropower plants:
Exp.1 V/F control of squirrel cage induction motor using DSP/dSPACE controller (i) open loop, (ii) closed loop.
Exp.2 Soft starting of induction motor using solid-state devices
Exp.3 Hysteresis current control of induction motor
Exp.4 Vector control of induction motor drive using DSP/dSPACE controller
Exp.5 Sensorless vector control of induction motor drive using DSP/dSPACE controller
Exp.6 Speed control of wound rotor induction motor using Static Kramer Drive method
Exp.7 Speed control of wound rotor induction motor using Static Scherbius Drive method
Exp.8 Start-up transient analysis of wound rotor induction machine.
Exp.9 Vector control of wound rotor induction with rotor power converter

Control of synchronous machines used in hydropower plants:
Exp.10 Closed loop voltage control of synchronous generator
Exp.11 Real and reactive control of synchronous generator
Exp.12 Vector control of synchronous machine

Control of mini hydropower plants:
Exp.13 Condition monitoring of hydro generators based on (i) stator current, (ii) vibration, (iii) thermal image processing
Exp.14 PLC based closed loop control system for (i) speed, (ii) current, (iii) voltage, (iv) water level

WR-553 Design of Construction Job Facilities

Requirements of material handling, mechanization of material movements on construction for construction sites for handling of earth and concrete
Belt and bucket conveyors, bucket elevators, screw conveyors and calculations for sizes and capacities of conveyors including design of principal components
Selection of type and design of pneumatic conveyors for conveying bulk cement
Hoisting equipment and its design and selection for different working conditions
Selection of type and design of cable-ways for aerial transportation and placement of concrete
Design of compressed air and water supply system on construction projects; Estimating construction power requirements
Design and layout of plant for production of aggregates including scalping crushing screening, washing, stockpiling and reclaiming
Planning for shop services; base and field workshops; layouts for workshops and principal workshop equipment; equipment for structural fabrication.
WR-554 Construction Plant Machinery

Mechanized nature of modern construction and responsibilities of mechanical engineers on construction projects, functional classification of construction equipment; Different types of prime movers, power ratings, power available, useable power, power requirements

Grade-ability and pull ability, analysis of combined influence of rolling resistance and traction on ability to negotiate grade and ability to pull trailing load by track-mounted and wheel-mounted construction equipment

Analysis and application of different types of planetary, hydraulic and hybrid transmissions for track-mounted and wheel-mounted construction equipment

Analysis and application of different types of mechanical, hydraulic, electric and hybrid controls for steering and braking of track-mounted and wheel-mounted construction equipment

Equipment specifications and procurement procedures, old versus new and indigenous versus imported equipment; Performance computations and production estimates

Sizing, matching and efficient utilization for optimal production of principal construction plant and machinery

Cost accounting, maintaining records and preventive maintenance of construction plant and machinery

WR-555 Air Conditioning and Ventilation

Introduction: Types of air-conditioning systems, design conditions, heat transfer coefficients for indoor and outdoor conditions

Load Estimation: Refrigeration and air conditioning load estimation, heat gains through structures

Ventilation: Necessity; ventilation standards; natural and mechanical ventilation; forces for natural ventilation; general ventilation rules; advantages of mechanical ventilation; various methods; ejector systems; determining ventilation requirement; use of decay equation.

Air cleaning: Physical and chemical vitiation of air, permissible concentration of air contaminants, mechanical and electronic air cleaners, dry and wet filters, air sterilization, odour control

Air-conditioning and ventilation ducts: Layout and design

Others: Refrigerants; System noise and its control, Environmental issues; Controls for air conditioning and ventilation systems

WR-556 Construction Techniques

Construction planning, job and resource planning, construction scheduling, mechanization in heavy construction, construction plant and its functional classification

Selection of type, size and number of construction equipment and techniques for excavation at borrow-pits, transportation from borrow-pits to fill sites, placement, compaction, and quality control for construction of embankments and earth and rockfill dams

Selection of type, size and number of construction equipment and techniques for manufacture, transportation, cooling, placement and quality control of concrete for construction of concrete dams/spillways/other structures

Selection of type, size and number of construction equipment and techniques for tunneling and underground powerhouses in squeezing, weak, moderate and sound strata

Flood frequencies for design of river diversion works, techniques for river diversion, economical height of coffer dams and diameter of diversion tunnels; Different techniques for dewatering, design of pumping and well-point dewatering systems

Foundation treatment of concrete and earth dams; Consolidation and curtain grouting, dental treatment and cutoff trenches

Equipment and techniques for aggregate recovery, processing and conveyance; Construction utility services
# Academic Curriculum for Master of Technology/ P.G. Diploma in IRRIGATION WATER MANAGEMENT (IWM)

<table>
<thead>
<tr>
<th>S. No</th>
<th>SUBJECT CODE</th>
<th>COURSE TITLE</th>
<th>SUBJECT AREA</th>
<th>CREDITS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Theory</th>
<th>Practical</th>
<th>Exam. Duration (Hrs.)</th>
<th>Relative Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st YEAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>1. WR-501</td>
<td>System Design Techniques</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>2. WR-571</td>
<td>Design of Irrigation Structures and Drainage Works</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>3. WR-572</td>
<td>Soil and Agronomy</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>4. WR-573</td>
<td>Principles and Practices of Irrigation</td>
<td>PCC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>5. Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2nd YEAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II SEMESTER (SPRING)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. WR-574</td>
<td>Diagnostic Analysis</td>
<td>PCC</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>3. Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>4. Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>5. Program Elective Course</td>
<td>PEC</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>6. WR-700</td>
<td>Seminar</td>
<td>SEM</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Note: P.G. Diploma course in IWM shall be of ONE YEAR duration comprising of semesters I and II only, with a minimum credits of 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 3rd YEAR |              |              |              |         |   |   |   |        |           |                        |                        |
| III SEMESTER (AUTUMN) | | | | | | | | | | | | |
| 1. WR-701A | Dissertation Stage I | DIS | 12 | - | - | - | - | - | 40 | - | - | - | - |
| Sub Total | | | | | | | | | | 12 | | |
| * to be continued and grade to be awarded in the next semester |

| IV SEMESTER (SPRING) | | | | | | | | | | | | |
| 1. WR-701B | Dissertation Stage II (contd. From 3rd Semester) | DIS | 18 | - | - | - | - | - | - | 60 | - | - |
| Sub Total | | | | | | | | | | 18 | | |
| Total | | | | | | | | | | 70 | | |
WR-501  **System Design Techniques**

System concepts: Boundary, environment, input, output and constraints; Open and closed systems; System modeling, water resources systems, issues in system application; Operation research approach to system analysis.

Linear programming: Model formulation, graphical method, simplex procedure- two phase, big-M, dual simplex, primal-dual simplex, modified simplex procedures; Upper bounded solutions, sensitivity analysis.

Transportation problems: Basic feasible solution techniques, testing for optimal solution; Integer and mixed integer problems, assignment problems, applications for efficient water resources management.

Non linear programming (NLP): Separable and convex programming problems, quadratic programming, unconstrained and constrained NLP problems, chance constrained programming, method of calculus, search techniques.

Dynamic programming: Optimality principle, deterministic and stochastic dynamic programming, application to water resources problems.

Decision making: Value and utility concepts, goal programming, decision theory and decision trees, decision making under risk and uncertainty, theory of games; Multi criteria decision making- distance based and compromise techniques.

WR-571  **Design of Irrigation Structures and Drainage Works**

Planning and layout of irrigation system: Necessity, advantages and types of irrigation, techniques of water distribution, alignment.

Crop water requirement: Duty, delta base period, irrigation efficiencies, consumptive use, net irrigation requirement, frequency of irrigation; canal capacity, rotational delivery, conveyance and seepage losses.

Design of lined and unlined channels: Design for clear and sediment laden water, principles of maximum and minimum permissible velocities, theory of sediment transport, regime concept; Kennedy theory; Lacey’s theory; economics of canal lining, discharge measuring devices.

Design of distributary head regulator and cross regulator: Hydraulic design principles, seepage theory, exit gradient, invert filter,
protection works.
Design of canal falls/drops: Definition, location and types of canal falls, design principles of vertical drop and fall, Sarda type fall; Glacis type fall; canal escape and their function as safety valve.
Water logging: Causes of water logging, types of drainage system, surface drains; layout and design of surface drains their operation and maintenance.
Flood control/protection: Design flood and its importance, flood management, structural and non-structural measures

WR-572 Soil and Agronomy
Introduction: Scenario of agriculture in the world characterization of irrigated and rain-fed agriculture.
Crops and plants: Definitions, morphological and physiological features, classification, adaptation and ecology.
Agro-climate: Elements of weather, analysis of weather data and agro-climatic classification, biomass production potential assessment and yield estimation.
Soils: Physical, chemical and biological properties, Taxonomic classification and characterization.
Soil survey for land evaluation: Irrigability and drainability classification, evaluation and productivity assessment of land.
Principles and practices of cultivation of crops: Husbandry of cereal, pulses, oilseeds and cash crops; package and practices of crops.
Agro Technology Software: Use of computer software like Decision Support System in Agro Technology Transfer (DSSAT) and other crop yield models.
Statistical analysis of experimental data: Field experimental techniques; yield estimation and production forecasting.
Optimization Techniques: Application of system techniques in crop planning and management

WR-573 Principles and Practices of Irrigation
Introduction, basic definitions and approach, water resources and its status, problems of irrigation development
Soil water plant atmosphere relationship, monitoring of crop water stress and soil moisture, water uptake and release in the atmosphere and root zone, consumptive use determination from field and Lysimetric experiments
Rainfall-runoff analysis, water availability assessment, infiltration, hydraulic conductivity and water balance study
Approaches of estimating reference crop evapotranspiration, crop coefficient; Effective rainfall, net irrigation requirement, gross irrigation requirement, project irrigation requirement; Preparation of water demand sheet
Crop growth stages; Soil moisture depletion; Miscellaneous uses of irrigation
Basin, border, furrow, sprinkler and drip irrigation and their design procedures; Evaluation of irrigation performance; Irrigation pumps; Automation in irrigation
Water quality testing, classification, treatment and management; Groundwater quality contamination, effluent and wastewater use in agriculture

PROGRAMME ELECTIVES

WR-503 Water Resources Planning and Management
Objectives of water resource development; needs and opportunities; societal goals.
Spatial and temporal characteristics of water resources; constraints for its development like non-reversibility; planning and horizon.
Financial analysis of water resources projects; allocation of cost of multipurpose projects; repayment of cost.
Demand for drinking water; irrigation, hydropower; navigational; planning for flood control.
Characteristics and functions of reservoir; reservoir sedimentation; conservation storage; conflict among uses, Reservoir operation studies - effect on river regime; long term simulation; reliability; resiliency and vulnerability assessment.
Ground water evaluation; conjunctive use of surface and ground water.
Discounting techniques; benefit cost parameters; estimation of benefits and costs; appraisal criteria; social benefit cost analysis.
Basin planning; inter-basin transfer of water.
Environmental impacts assessment guidelines and case studies.

WR-504 Applied Hydrology
Introduction: Hydrologic design requirements, hydrologic cycle, classification of processes and models
Hydrologic Data: Observation and collection; Processing - supplementing, consistency checking, corrections and presentation
Frequency Analysis: Probability distributions, statistical analysis, return period of flood and storm, outliers, regional flood frequency, confidence interval and goodness of fit
Rainfall runoff models: Empirical, conceptual and physical; Unit hydrograph; Decisions with inadequate hydrologic data
Hydrologic Design: Design criteria, dependable yield, design storm, design flood estimation, reservoir and channel routing
Flood Forecasting: Travel time, correlation, telemetry, gage and discharge forecasting
Elements of Groundwater Hydrology: Ground water recharge, ground water balance, aquifer properties

WR-513 Earth and Rock Fill Dam
Materials properties of soils: Pore pressure parameters; Hilf Bishop method; Shear strength of soils; Mohr Coulomb failure criterion; Factors contributing to slope failure
Design criteria: Types of earth dams; Design considerations- Freeboard calculations, dam section, upstream slope protection; Design considerations in earthquake regions; Filter design; Causes of damage and failure, typical case studies.
Seepage control: Control of seepage through earth dam on pervious soil foundation and on impervious base; Cutoff trench; Sheet pile; Alluvial grouting; Slurry trench; Horizontal upstream blanket; Relief wells; Loading berm; Treatment of rock foundations and grouting
Stability analysis: Total and effective stress methods of analysis; Standard method of slices, Simplified Bishop method; Wedge method; Stability conditions during construction, full reservoir and reservoir drawdown
Analysis of dam: Introduction to finite element method (FEM); FEM analysis of dams; Nonlinearity in soils
Rockfill dam: Considerations favouring choice of a rockfill dam; Principles of design; Selection of materials; Stability analysis by wedge method, Different types of impervious cores and their locations; Different types of face members; Settlement in rock fill dams; Procedure for placement and compaction of rock fill
Instrumentation in earth dams: Measurements of deformations, pore pressures; Quality control; Foundation preparation and treatment; Quality control of materials and control of moisture, laying and compaction; Tests for quality control; Diversion during construction

WR-516 Rural and Urban Water Supply
Introduction: Planning and preparation of water supply schemes for rural and urban areas; Issues in water supply for hilly and coastal regions, regional and national perspective; Water pricing
Water Demand: Population forecasting, assessment of domestic, fire, industrial and public demands, demand management
Water Supply Sources: Surface and sub-surface, selection, protection, contamination protection zone, estimating potential yield and sustainability; Design of wells
Water Quality: Drinking water quality parameters, comparison of international and national codes, physical and chemical treatment processes, disinfection and appropriate technologies for water treatment
Components of Intake Works: Sizing water mains, pumps for water supply, pumping station, pipe appurtenances, pipe materials, laying of pipes, design of water distribution network and allied works.
Water Distribution Networks: Flow through pipes, equivalent pipes, solving pipe network flow problems, use of computer software for network analysis

WR-520 Environmental Impact Assessment of Water Resources Projects
Introduction: Human concern; Need for environmental impact assessment (EIA); Requirements and levels of EIA; Potential impacts of water resource development projects
EIA Procedure: Screening, baseline data, scoping, terms of reference (TOR)
Environmental Clearance: Guidelines, acts and legislations, codes and country practices
Environmental flow: River as habitat, downstream direct and indirect uses, criteria and methods of assessment
Soil and Water Quality Management: Effect of project development on soil and water quality, water logging, soil salinity, and contamination, remedial measures
Rehabilitation: Submergence effects, rehabilitation guidelines, planning, and procedures
Monitoring: Parameters to be monitored, frequency of monitoring, reporting procedures
Remote Sensing and GIS Applications: Monitoring of land use changes, digital elevation model (DEM), assessment of land degradation, catchment area treatment plan
Simulation Exercises and Case Studies

WR-522 Climate Change and Water Resources
Introduction to atmospheric science; Earth, its atmospheric cycle and its relation with climate; Green house gas and climate change; Earth and green house effect; Past climate change; Lessons from history; Present and future climate changes
Ecological effect on freshwater systems- surface water, ground water and glaciers; Agriculture; Marine environment; Causes, human dimension- impact of human settlement and infrastructure, environmental quality
Analysis for climatic change assessment, statistical analysis of long-term meteorological and hydrological data; Trend analysis
Available climatic models such as GCM; Hydrologic models such as SWAT and Mike11; Downscaling of GCM to regional/local scales
Mitigation- capture of sequester carbon emissions, reducing global warming, renewable energy technologies, efficient use of energy
Policy, laws, economics, benefits and costs of mitigating climate change, international cooperation
On Farm Development

Introduction, techno-economic and environmental issues of canal commands; Command area development programme- Objectives and approach.

On Farm Development Planning- Delineation of watershed, land acquisition, delineation of farm roads, field channels, field drains and escapes; Land leveling, shaping and earth work estimation.

Identification and reclamation of waterlogged and salt-affected lands through cultural, chemical and engineering practices.

Water distribution practices in India and other neighboring countries in canal, tube well, small storage and diversion structures; On farm system design- Modernization and rehabilitation of water-courses and their structures.

Agricultural extension- Farmer's organization, leadership development and linking farmers- with agriculture, irrigation and financing; Rural and infrastructural development agencies.

Participatory irrigation management- Irrigation management transfer, responsibility of irrigation department and farmers' organization, constitution, laws and bye laws, social, economic and environmental control of water users' society.

Runoff recycling, planning mixed use of fresh and effluent water in agriculture.

Conjunctive use planning- Use of surface and ground water to improve water productivity, safeguard against land degradation and environmental protection; Sub surface drainage- Layout and Design.

Operation Maintenance and Management of Irrigation Systems

Definition of terms, elements of organizational management; Comparative analysis of irrigation organization, organizational change mechanism.

Maintenance problems- physical and social phenomena, examples; Maintenance types- essential, structural, catch up, preventive and normal; Budget control and accountability development of maintenance program.

Maintenance practices- catchment protection to check soil erosion, headworks; Maintenance of channels, structures, communication and ancillary works; Maintenance of tertiary systems and drains.

Diagnostic analysis of operation and maintenance of a canal system; Purpose, planning, field work, walk-through survey, field experiments, report preparation and presentation.

Reservoir and canal operation- reservoir operation rules for flood control and water supply; Canal capacity, discharge measurement, water allowance, water distribution, planning and sharing in water deficit.

Automatic regulation of canal operation- concept of automation, hardware and software requirements, gate discharge, pool volume control; Algorithm for canal operation.

Information management- geographic information system based record keeping and analysis, information flow and feedback.

Water charges, revenue recovery and performance budgeting.

Water and Land Laws

Water laws in India: Basic concepts of resource economics applied to water resource management, fugitive nature of water resources, common property rights; Constitutional right, surface and ground water use regulations.

National policies: Agriculture, water, forest and science policies; North India canal and drainage act.

Land laws in India: Legal aspects of land ownership, inheritance, disputes and their resolution.

Environmental protection act: Rules and regulation, effluent disposal and pollution control laws.

Water rights: Comparative analysis of surface and subsurface water rights, legal procedures for establishment of water rights, groundwater legal issues, group versus individual rights.

Water disputes and their resolution: Interstate, inter-basin and trans-boundary disputes; Conflict resolution, development of accountability mechanism.

Organizational setup: Water boards and authorities; Case studies of users' interactions with government agencies.

Rural Sociology and Irrigation Economics

Rural sociology: Elements of rural sociology, social structure and their interaction, moral values, irrigation for social service and rural development.

Social structure: Rural psychology, leadership, communication and motivation for effective governance.

Panchayati raj act: Panchayati raj institution and rural development programs.

Social upliftment: Social conflicts and their resolution, role of NGOs and women in irrigation management.

Principles of economics: Definitions, basic concepts of water resource economics, analysis and project planning for irrigation management.

Farm accounting: Production response, functions of irrigation application.

Pricing of water: Socio-economic aspects, time-value of money, determination of demand; Pricing policy- guidelines and estimation.

Socio-economic surveys: Principles and guidelines.
WR-579 Evaluation of Irrigation Projects
Introduction: Need for evaluation of irrigation projects; Principles of system diagnosis, health of an irrigation system for its functioning.

Cropping system: Cropping pattern, cultivation techniques, crop diversification, intensification and rotation; Yield estimation.

Performance evaluation: Benchmarking, guidelines and procedures for command area project evaluation.

Water productivity: Modern concepts, economics, limits and opportunities for improvement, management of floods and droughts.

On farm system: Field level assessment of efficiencies, efficient use of rain water.

Main system: Basic concepts of irrigation systems, system boundaries, interaction between environment and system, system deficiency.

Socio-economic: Social structure, per capita income, livelihood improvement.

WR-580 Renewable Energy System Technology

Renewable energy: Definition, history, current state-of-the-art, future use and penetration of renewable energy technologies;
Types of renewable energy sources - Solar radiation, tidal and waves, hydro cycle, geothermal.

Solar thermal energy conversion technologies: Nature of solar radiation; Insolation; Measurements and estimation; Physical principles of conversion of solar radiation into heat; Flat plate collectors, energy balance equation and collector efficiency, concentrating collectors and flat plate collectors, solar thermal electric power generation.

Solar photo voltaic systems: System components and configurations, cells, modules, and arrays, batteries, charge controllers, inverters, system sizing, mechanical integration, electrical integration, utility interconnection.

Wind energy: Wind characteristics, data analysis and resource estimation; Wind turbine energy prediction; Measurement of wind velocity and direction; Wind turbine configurations- drag and lift types; Magnus effect in wind turbines; Vortex wind machines; Electric generators for wind turbine application; Power converter, auxiliary equipment; Wind turbine control; Wind turbine sitting considerations; System economics; Environmental aspects and impacts.

Tidal power: Tidal phenomena, historical background, basic aspects of tidal power development and tide mills; Tidal power project components; Design considerations- Selection of tidal power sites, feasible tidal range, preliminary design and productivity considerations; Tidal barrier construction techniques- dikes, types of float in modules, concrete caissons.

Bio mass energy: Biomass conversion technologies, generation, bio-digestion; Classification of biogas plants- floating drum type and fixed dome type; Thermal gasification of biomass; Biomass gasifiers; Gasification process, application of gasifiers for electricity generation; Pyrolysis and alcohol fuels.

Other renewable energy sources: Wave energy and ocean thermal energy conversion technologies; Geothermal energy sources, geothermal exploitation, prime-movers for geothermal energy conversion system, material selection for geothermal power plants, flashed steam and total flow concept.

Applications: Application to micro-irrigation, rural water supply, water and waste water treatment, special conditions of preference – off grid and remote areas; cost effectiveness, use of software.

WR-581 Water Quality Monitoring and Modelling

Water quality parameters: Physical, chemical and biological parameters of natural water bodies like lake, river and estuary; Water quality standards, Eutrophication; Sources of pollution, mass bathing impacts, waste load allocation.

Water quality monitoring: Physical, chemical and biological monitoring of rivers; Guidelines for sample size and location of monitoring stations, Sample analysis.

Modelling: Characteristics of point and non-point sources of pollution; Solution of diffusion and dispersion problems; Water quality models, case studies.

Water purification: Physical, chemical and biological processes, response of streams to biodegradable organic waste; Engineered systems for water and waste water purification.

Groundwater quality: Parameters; Sources of salinity, short and long term monitoring; Remedial and preventive measures.

WR-582 Theory of Seepage

Fundamentals, characteristics and boundary conditions of groundwater flow; Darcy's law; General hydrodynamic equations; Flownet.

Application of Dupuit theory; Basic consideration; Two dimensional flow; Free surface subject to infiltration and evaporation; Radial flow in fully penetrating well.

Conformal mapping and special mapping techniques; Application of mapping function; Fundamentals of solution of two dimensional flow problems by conformal mapping; Bilinear transformation.

Unconfined flow through earthen structures and its seepage analysis; Unconfined flow around cutoffs; Earth structure with a cutoff wall and with horizontal drain; Rockfill dams with central core and seepage analysis.

Confined flow, methods of solving confined flow problems; Hydraulic structure on surface of finite depth of porous media; Inclined sheet pile; Finite lower impervious boundary; Depressed structure on a permeable base of infinite extent; Double-wall sheet-pile cofferdam.
Seepage from small water bodies, reservoirs and canals; Seepage towards well- steady and unsteady flows; Stream-aquifer interaction.

WR-583 Remote Sensing and GIS Applications in Agriculture

Introduction, history of remote sensing, sensors, platforms and their characteristics; Satellite data products.
Principles of remote sensing and data analysis, electromagnetic spectrum, atmospheric effects, energy interaction with earth surface features, basic interaction mechanism of soil, vegetation and water.
Image interpretation virtual and digital; Image rectification, image enhancement, image classification and accuracy assessment, use of image processing software.
Geographical information system (GIS), definition, essential components of GIS, spatial data structure- raster and vector, spatial and non-spatial relationship, geographic database concepts and analysis, GIS packages and salient features.
Use of remote sensing and GIS techniques in agriculture, vegetation cover mapping, crop acreage estimation and disease detection.
Application of remote sensing and GIS for estimation of surface and groundwater irrigation potential, erosion hazard assessment, water quality assessment, flood inundation mapping and modeling; Drought monitoring; performance evaluation of irrigation commands; Selection of site for artificial recharge, agricultural management and planning.

WR- 584 Cropping System Modeling

Introduction: Need of crop modeling, crop modeling, advanced crop cultivation techniques.
Constraint analysis: Crop, soil and hydrological constraints, analysis of problems, remedies for optimal crop yield.
Agricultural lands problems: Land and water degradation problems due to use of fertilizers, water and agro-chemicals.
Crop diversification: Need, process and forms; Crop intensification, intensive cropping systems.
Systems approach: Use of linear programming in crop planning and management.
Crop models: Use of CROPWAT for yield estimation, water uptake and nitrogen uptake forecasting.
Decision support system (DSS): Basic concepts, development of DSS for agro-technology transfer.

WR-585 Environmental Impact of Irrigated Agriculture

Introduction: Definition, basic environmental issues in irrigated agriculture, scope.
Ecology: Flora and fauna in irrigated areas, soil and water-borne pathogens of crops and trees, fertility and productivity of lands.
Ecological adaptation: Competition, adaptation and adoption of crop and weeds under variable soil moisture condition.
Nutrient and water balance: Organic carbon, major and micronutrient requirements of crops and soils, nutrient and water use efficiency; Model studies in nutrient and water balance studies.
Soil, water and plant chemical analysis: Collection of samples, preparation of standard solution and analysis; Use of advance techniques for chemical analysis.
Climatologically changes in irrigated areas: Soil degradation; Crop extinction; Human and animal diseases.
Microclimate: Micro environment study of field crops, instrumentation for microclimatic study.
Field studies: Project work on field observation, recording of data and statistical analysis.

WR-586 Groundwater Development and Management

Use of groundwater and its impact on irrigation water management; Hydrologic properties of water bearing formation, occurrence, storage and distribution of groundwater; Use of groundwater zone maps; Groundwater resource assessment and budget.
Surface investigations of groundwater; Well hydraulics- steady and unsteady flows; Water wells- test holes and well logs; Design, construction and development of shallow and deep wells, design of screen and gravel packs.
Pumps and their selection, installation and testing of pumps; Monitoring and maintenance of wells, causes of failure.
Ground water conservation and artificial recharge, sustained yield, water balance equation; Ground-water and surface-water interaction, interference of wells; Watershed conservation measures in irrigation commands.
Groundwater flow parameter estimation; Groundwater simulation and conjunctive use models, comparative analysis for management of conjunctive use system.
Groundwater quality- agricultural sources of pollution, causes and monitoring; Technical, socio-economic and organizational aspects of groundwater management.

WR-587 Watershed Development and Management

Components of watershed and need of watershed management; Principal factors influencing watershed operations; Delineation of watersheds; Engineering surveys; Data requirement.
Watershed hydrology, water resources assessment in watershed, hydrological cycle; Surface water assessment- rainfall-runoff analysis; Groundwater assessment, infiltration and its measurement.
Watershed Behavior- Physical elements of watershed, effects of land use changes on hydrological cycle components, watershed experiments.
Land capability classification; Erosion process- factors affecting erosion, types of erosion, soil erosion models.
Engineering measures for soil and water conservation- Contour bunding, graded bunding, bench terracing, land leveling and grading; Small storage structures- Types and design data requirement, loose boulder dams, gabions, check dams and their design criteria.
Rainwater harvesting, direct and indirect methods, filter design, planning and design; Layout and execution; Impact assessment, operation and maintenance issues.
Watershed management plan- Methodology of planning a watershed, identification of watershed problems, socio-economic issues including application of Remote sensing and GIS in watershed management.

5.3 Performance Evaluation & Grading
As per regulations in vogue, the evaluation of academic performance of students is done on continual basis throughout the semester. In the credit and grading system of evaluation, passing and failing is done course wise (subject wise). Promotion of a student to the next semester is linked to his obtaining a certain minimum grade point average and his earning of certain minimum number of credits in a semester and up to that semester. The award of degree/diploma is also linked with the earning of total number of credits along with other requirements, as specified for each programme.
A student is evaluated for his academic performance through practical, class work, home work assignments, term papers, field work, quizzes, tests, examination, viva-voce etc. in each semester, as per regulations. Evaluation in every course (subject) is based on weightage of marks/grades assigned to various courses as per curricular structure.
Note:
The Academic Curricula containing all Ordinances and Regulations including the method of awarding the grades will be distributed at the time of registration.
(A) Full time sponsored candidates must have a minimum of two years of full-time work experience till the last date submission of application form in responsible capacity in a Registered Firm/Company/Industry/Educational and Research Institution/Govt./Quasi Govt./Autonomous Organization in the relevant field in which admission is being sought. The Firm/Company/Industry shall either be a public sector undertaking or a public limited undertaking registered in a stock exchange or a private concern whose annual turnover during the past 2 years exceeds Rs. 5.0 crores. For a candidate employed in an educational Institution, it should be recognized by AICTE.

(B) Candidates having AMIE/AMIS/AMIChE/AMIIM/Grad IETE, who possess B.Sc. or Diploma in engineering and have at least three years research, teaching or other professional experience at the submission of last date of application acquired after passing the qualifying examination in relevant field, are also eligible to apply for admission to M.Tech. Courses.

NOTE: The candidates working in Government/Semi government/PSU organization ONLY are eligible to apply through this information brochure.
WATER RESOURCES DEVELOPMENT AND MANAGEMENT
Indian Institute of Technology Roorkee, Roorkee – 247667, India
(Application Form for Sponsored Candidates only)

APPLICATION FORM (2016-2017)

(Please select one Academic Programme out of A or B and tick in appropriate box)

<table>
<thead>
<tr>
<th>A) Water Resources Development</th>
<th>B) Irrigation Water Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please check eligibility criteria to the Programme in which admission is sought

☐ Training Certificate ☐ P.G. Diploma ☐ M.Tech Degree

Name (block letters)
(Mr/Ms*)……………………………………………………………………………………………………………………
(Surname)               (Middle name)              (first name)

Present Address: …………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………

Tel. & Fax (with code): ……………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………

Email: …………………………………………………………………………………………………………………………………

Permanent Address: …………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………

Tel. & Fax (with code): ……………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………

Email: …………………………………………………………………………………………………………………………………

Place/Country of birth ………………. Date of birth……………….. Citizenship………………………….

Marital Status*: Married/Unmarried.

Proof of proficiency in English (for foreign students only): ……………………………………………………………

A) Academic qualifications other than Engineering (beginning from High School):

<table>
<thead>
<tr>
<th>College/Institution Name and address</th>
<th>Degree or Examination passed</th>
<th>Year of Passing</th>
<th>Division with % of marks/ Grade Point Av.</th>
<th>Position/ Distinction</th>
<th>Main Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Paste the Attested Photograph

31
B) Professional/Engineering Qualification:

<table>
<thead>
<tr>
<th>College/Institution Name and address</th>
<th>Degree or Examination passed</th>
<th>Year of Passing</th>
<th>Division with % of marks/Grade Point Av.</th>
<th>Position/Distinction</th>
<th>Main Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C) Employment Record and Experience:

<table>
<thead>
<tr>
<th>Name of Department</th>
<th>Position held</th>
<th>Period From</th>
<th>To</th>
<th>Details of work done</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Name & Signature of Applicant

NOTE:

1. Applicant should strike off whichever is not applicable to him/her.
2. Attach attested copies of the certificates.
3. In case of award of grade points, please attach a certificate from the issuing University/Institution explaining the conversion formula for converting grade point average to percentage marks.

D) Recommendations of Sponsoring/Nominating Authority

The undersigned is pleased to sponsor Mr./Ms. ………………………………… who is working in this organisation for the last ………… years and is presently holding the rank/position of …………………………………… for pursuing the P.G. Diploma Programme / M.Tech. Degree Programme in …………………………………………… at IIT Roorkee in the WRD&M.

His/Her conduct and character is good.

The Institution/Organization would relieve him/her immediately for joining the above course, if selected for admission. The Institution/Organization also agrees to pay all the contingent/expenses stipulated by the Institute. This is further certified that the sponsorship for admission will not be withdrawn midway till completion of the course.

Place : ………………… Signature of Head of the Institution/ Organization with seal

Date : ………………… Name: …………………………………

Designation …………………………………

NOTE: Medical Certificate in the enclosed Performa to be submitted with this application form.
A. Candidate's Declaration

1. Name ……………………………………………………………………………………

2. Whether you have been treated for
   (a) Hypertension (High Blood Pressure) Yes/No
   (b) Diabetes Yes/No
   (c) Mental illness Yes/No

3. Mark of Identification
   (Signature of Applicant)
   Dated……………… ….

B. Doctor's Certificate

I certify that I have carefully examined Mr./Ms and find that he/she is healthy and he/she has no disease constitutional weakness or bodily deformity or medical infirmity rendering him/her unfit now or in future, for active outdoor service and strenuous studies except

I do not consider/do consider it a disqualification for admission to Indian Institute of Roorkee, Roorkee

1. Height (without shoes) Weight (with thin clothes)
2. Chest (over nipples) on complete expiration On full inspiration
3. Are gums and teeth healthy ?
4. Any evidence of Adenitis, skin or venereal diseases
5. Any evidence of Epilepsy
6. Any signs of mental illness or drug addiction
7. Is the chest symmetrical and lungs normal?
8. Is the hearth normal in size and sounds normal?
9. Blood pressure systolic ………………………….. Diastolic………………….
10. Eye sight R/E …………………..L/E…………………..(Distance and near vision)
    Does he/she use glasses and if so, Power of glass R/E………………L/E………
    1. Reading……………………
    2. Distant……………………
11. Is there only other disease of eye including Colour/Night blindness? Is tracoma present?……………………
12. Any evidence of enlargement of Liver of Spleen or Anaemia present?…………
13. Is Hydrocele or Hernia present ? If operated, is the scar healthy?………………
14. Urine RE ………………………………………………………………………….
15. X-Ray Chest PA………………………………………………………………
16. ELISA test (foreign students and candidates who have visited a foreign country within the last 6 months).…………………………………………
    For Female candidates
    Any evidence of gynecological disorder……………………
    Condition of Breasts/Uterus……………………………………….
    Period of gestation (if pregnant)……………………………

   (Signature of Doctor)
   Name and Designation
### ESTIMATE OF EXPENSES

*(for sponsored candidates only)*

Approximate expenses under different heads are indicated below:

<table>
<thead>
<tr>
<th>S.N</th>
<th>Particulars of Expenditure</th>
<th>Indian Officers</th>
<th>Foreign Officers on Fellowship from ITEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rs. 68,080</td>
<td>Rs. 68,080.00</td>
</tr>
<tr>
<td>1.</td>
<td>Institute Fee*</td>
<td></td>
<td>(In Indian Rs.)</td>
</tr>
<tr>
<td>2.</td>
<td>Lodging &amp; Electricity charges**</td>
<td></td>
<td>Rs. 30,000</td>
</tr>
<tr>
<td>3.</td>
<td>Books and stationery**</td>
<td></td>
<td>Rs. 5,000</td>
</tr>
<tr>
<td>4.</td>
<td>Study Tour and visits to projects</td>
<td>Rs. 5,000</td>
<td>Rs. 5,000</td>
</tr>
<tr>
<td>5.</td>
<td>Outfit and medical expenses**</td>
<td></td>
<td>Rs. 5,000</td>
</tr>
<tr>
<td>6.</td>
<td>Pick Up and Drop From Airport Expenses</td>
<td></td>
<td>Rs. 6000</td>
</tr>
<tr>
<td></td>
<td><strong>Sub Total</strong></td>
<td>Rs. 73,080</td>
<td>Rs. 1,19,080</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rs. 73,080</td>
<td>Institute fee as applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rs. 1,19,080</td>
<td></td>
</tr>
</tbody>
</table>

For **I**<sup>st</sup> and **II**<sup>nd</sup> Semester Training / P.G. Diploma / Master of Technology *(First Year)* 52 Weeks

| 7.  | Institute Fee                                                    | Rs. 59,580      | Rs. 59,580                             |
| 8.  | Lodging and electricity charges**                                |                 | Rs. 30,000                             |
| 9.  | Study tour and visits to project                                 | 5000            | Rs. 5,000                              |
| 10. | Outfit and medical expenses**                                    |                 | Rs. 5,000                              |
|     | **Sub Total**                                                    | Rs. 64,580      | Rs. 99,580                             |
|     |                                                                  | Rs. 64,580      | Institute fee as applicable             |
|     |                                                                  | Rs. 99,580      |                                        |

**Grand Total** | Rs.1,37,660  | Rs. 2,18,660  |
|                | Institute fee as applicable                                     |                |

* Revision of **Institute fee** is under active consideration of the administration. The Institute fee includes: tuition, examination, enrolment, medical, internet, computer, extra curricular activity, and admission, grade card, student welfare, modernization, identity card, benevolent, alumni and library etc.

** As per the terms & conditions of sponsoring agency.

Note: 1. Charges at sl.no. 1 in **I**<sup>st</sup> Semester and sl.no. 7 in **III**<sup>rd</sup> Semester are to be deposited at the time of registration in respective semesters through a Demand Draft in favour of Chairman P.G. Admission IIT Roorkee payable at any Nationalized Bank at Roorkee. Charges at sl. no. 4 & 9 are to be deposited in cash or by DD in favour of O.C. Tour WRD&M, IIT Roorkee.

2. In addition to above, the boarding charges have to be borne by students/trainee officers themselves.

3. Charges at sl no. 2 & 8 are for ITEC sponsored candidates/TCS sponsored candidates.
VISION

To be the fountainhead of new ideas and innovations in science and technology and continue to be a source of pride for all Indians.

MISSION

To create an environment that shall foster the growth of intellectually capable, innovative and entrepreneurial professionals, who shall contribute to the growth of Science and Technology in partnership with industry and develop and harness it for the welfare of the nation and mankind.

कुल गीत

जयति जयति विद्या संस्थान,
हिम गिरि श्रृंगरों से अभिनंदित,
गंगा जल करते कल गान। जयति।।

शिक्षा आदर्शों में उन्नत,
जीवन शिल्पी भूरू रचना रतं,
‘श्रम बिना न किमपि साध्यम’ व्रतं,
यज्ञ कला कौशल अभियान। जयति।।

कन जीवन प्रासाद उठाकर,
सेतु बाँध भू खण्ड जुड़ाकर,
अंतरिक्ष में यान उड़ाकर,
नव युग को देता आह्वान। जयति।।

सुजन हित जीवन नित अर्पित,
धरा स्वर्ग शोभा कर निर्मित,
वैज्ञानिक युग पट में पूर्ति,
भू पर लाता स्वर्ण विहान। जयति।।

नयी ग्रेना से दीपित मन,
नव स्वर्णों से हरिष्ट लोचन,
नए सत्य की उर में धड़कन,
ध्वेय राष्ट्र जीवन कल्याण। जयति।।

( रचयिता – श्री सुभिन्नानन्दन पंत )

CORE VALUES

- Academic integrity and accountability
- Respect and tolerance for the views of every individual
- Attention to issues of national relevance as well as of global concern
- Holistic understanding, including knowledge of human sciences
- Appreciation of intellectual excellence and creativity
- An unfettered spirit of learning explorations, rationality and enterprise
- Sensitivity to social responsibilities
STRENGTHS OF THE DEPARTMENT

Civil Engineering
- Water Resources System Planning and Management
- Design and construction of Dams, Barrages, Weirs, Spillways, Regulators, Canal Systems etc.
- Design and construction of Hydro Power Stations
- Rural and Urban Water Supply
- Climate Change and its impact on Water Resources
- Water Management for Sustainable Development

Civil/Agricultural Engineering
- Rehabilitation and Modernization of Irrigation System
- Canal Design and Networking
- Operation and maintenance of canal
- Design of Irrigation and flood control structure
- Ground water assessment, development and management
- Remote Sensing and GIS applications

Electrical Engineering
- Hydro power potential Assessment, planning and design
- Power Generation, Transmission and Distribution

Mechanical Engineering
- Hydro mechanical Equipments
- Hydro turbine installation and operation
- Construction Plant and machinery
- Design, installation and operation of Gates

Social Sciences
- Socio economic survey
- Participatory Irrigation Management
- Water Distribution Practices
- Water Productivity assessment
- Diagnosing System performance

Agricultural Sciences
- Crop water requirement and management
- Cropping Systems Studies
- Irrigation System design and evaluation
- Command area development and management
- Pressurized irrigation system design and operation
- Land reclamation and on farm development

Irrigation Water Management

Water Resources Development

Sciences
- Water quality degradation
- Land quality degradation
- Soil water conservation & Watershed management
- Surface and sub surface drainage
- Irrigability surveys

Printed by: R.K. Printers, Rke. Ph.: 270957, 9807276995