# ACADEMIC REGULATIONS

# COURSE STRUCTURE

# AND

# DETAILED SYLLABUS

# M.TECH (WATER AND ENVIRONMENTAL TECHNOLOGY)

**(Effective for the students admitted from academic year 2021-2022 onwards)**


## CENTRE FOR WATER RESOURCES

## JNTUH INSTITUTE OF SCIENCE AND TECHNOLOGY (AUTONOMOUS)

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

**Kukatpally, Hyderabad, Telangana State, INDIA-500085.**

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## Vision of the Institution

Imparting technical education that encourages independent thinking, develops strong domain of knowledge, hones contemporary skills and positive attitudes towards holistic growth of young minds.

## Mission of the Institution

- Student-centered Teaching-learning processes and a stimulating R&D environment.
- Providing Quality Education and ethics to students.
- State-of-art Infrastructure for professional aspirants.

## Vision of Centre for Water Resources

To generate advanced technical man power in order to develop techniques and methodologies by undertaking advanced research in the field of water and environment and to achieve university symbiosis by undertaking participatory approaches.

## Mission of Centre for Water Resources

- Student centered Teaching learning processes and a stimulating R&D environment.
- To build advanced laboratories for conducting research and to design sustainable systems for water and environment.
- To establish state of art infrastructure for professional training and to establish networking among the user agencies.

## Program Outcomes (POs)

**PO1:** An ability to independently carry out research /investigation and development work to solve practical problems

**PO2:** An ability to write and present a substantial technical report/document

**PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

**PO4:** Students should be able to cope with changing technological environment to meet the challenges emanating out of Climate change and Environment

***Note: Program may add up to three additional POs.***

## Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) are as follows:

**PEO1:** To prepare the students as one of the problems solving engineers/technologists in water, land and environmental fields.

**PEO2:** To generate technical man power at advanced level to maintain and manage the existing infrastructure of water, land and environment of the nation.

**PEO3:** To impart technical training to the students that empowers them to withstand changing technological environment in order to cope with the natural climate change and environment.

**PEO4:** To develop the students' personality in such a manner that they become responsible citizens in the society.

## BLOOM'S TAXONOMY


## KNOWLEDGE LEVELS

**Self-Assessment of a student is based on the answers given to the Blooms level of questions**

| The Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Facts | list | paraphrase | classify | outline | rank | categorize |
| Concepts | recall | explains | show | contrast | criticize | modify |
| Processes | outline | estimate | produce | diagram | defend | design |
| Procedures | reproduce | give an example | relate | identify | critique | plan |
| Principles | state | converts | solve | differentiates | conclude | revise |
| Meta-cognitive | proper use | interpret | discover | infer | predict | actualize |

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**INSTITUTE OF SCIENCE & TECHNOLOGY**
**(AUTONOMOUS)**
**Kukatpally, Hyderabad – 500 085**

# ACADEMIC REGULATIONS 2021-22

**For CBCS Based M.Tech. (Regular/Full Time) Programmes**
(Effective for the students admitted into I year from the Academic Year **2021-22**and onwards)

# ACADEMIC REGULATIONS 2021-22

## For CBCS Based M.Tech. (Regular/Full Time) Programmes

(Effective for the students admitted into I year from the Academic Year **2021-22**and onwards)

**1.0 Post-Graduate Degree Programmes in Engineering & Technology (PGP in E & T):**

JNTUH offers 2 Year (4 Semesters) full-time Master of Technology (M.Tech.) Degree Programmes, under Choice Based Credit System (CBCS) at its Autonomous Institute – Institute of Science & Technology with effect from the Academic Year **2021-22** onwards in different branches of Science & Technology with different specializations.

**2.0 Eligibility for Admission:**

Admissions to the PGPs shall be made subject to the eligibility, qualification and specializations prescribed by Institute of Science & Technology, JNT University Hyderabad, for each Specialization under each M.Tech. Programme, from time to time.

Admission to the PGP shall be made either on the basis of - the Rank/ Percentile earned by the candidate in the relevant qualifying GATE Examination/the Merit Rank obtained by the qualifying candidate at an Entrance Test conducted by the Telangana State Government (PGECET) for M.Tech. Programmes/an Entrance Test conducted by the Jawaharlal Nehru Technological University Hyderabad/on the basis of any other order of merit approved by the University, subject to reservations as prescribed by the Government from time to time.

The medium of instructions for all PG Programmes will be ENGLISH only.

**3.0 M.Tech. Programme (PGP in E & T) Structure:**

The M.Tech. Programmes in E & T of JNTUH-IST are of Semester Pattern, with 4 Semesters constituting 2 Academic Years, each Academic Year having TWO Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 Weeks duration (inclusive of Examinations), with a minimum of 90 Instructional Days per Semester.

**3.2.0** The student shall not take more than four academic years to fulfill all the academic requirements for the award of M.Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M.Tech. programme

**UGC/ AICTE** specified Definitions/ Descriptions are adopted appropriately for various terms and abbreviations used in these PGP - Academic Regulations, as listed below.

**Semester Scheme:**

Each Semester having - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester

System (CBSS) as denoted are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' or 'COURSE' imply the same meaning here, and refer to 'Theory Subject', or 'Lab Course', or 'Mini Project with Seminar', 'Project', as the case may be.

**Credit Courses:**

All Subjects (or Courses) are to be registered by a student in a Semester to earn Credits. Credits shall be assigned to each Subject/ Course in a L: T: P: C (Lecture Periods: Tutorial Periods: Practical Periods: Credits) Structure, based on the following general pattern …

- One credit for One hour/ Week/ Semester for Theory/ Lecture (L) Courses; and,
- One credit for Two hours/ Week/ Semester for Laboratory/ Practical (P) Courses or Tutorials (T).

Other student activities like Study Tour, Guest Lecture, Conference/ Workshop Participation, Technical Paper Presentations etc., and identified Mandatory Courses if any, will not carry Credits.

**Subject/ Course Classification:**

The Institute has followed the guidelines issued by AICTE/UGC. All Subjects/Courses offered for the PGP in E&T are broadly classified as Program Core, Program Elective, Open Elective, Audit Course and Mini Project with Seminar, Industrial Training and Dissertation.

**Course Nomenclature:**

The Curriculum Nomenclature or Course-Structure Grouping for the M.Tech. Degree Programmes is as listed below …

| ***S. No.*** | ***Broad Course Classification*** | ***Course Group/ Category*** | ***Courses Description*** |
|---|---|---|---|
| 1. | Core Courses (CoC) | PC- Program Core | Includes core subjects related to the Parent Discipline/ Department/ Branch of Engg. |
| | | Project work (Dissertation) | M.Tech. Project or PG Project or PG Major Project |
| | | Mini Project with Seminar | Seminar based on core contents related to parent discipline/department/branch of Engineering |
| | | Audit Courses | Mandatory courses (non credit) |
| 2. | Elective Courses (EC) | PE– Program Electives | Includes Elective subjects related to the Parent Discipline/ Department/ Branch of Engg. |
| | | OE-Open Electives | Elective subjects include inter-disciplinary subjects. |

*** Students be encouraged to go to Industrial Training/Internship for at least 2-3 months**

**during semester break.**

**Course Work:**

A Student, after securing admission, shall pursue and complete the M.Tech. PGP in a minimum period of 2 Academic Years (4 Semesters), and within a maximum period of 4 Academic Years (starting from the Date of Commencement of I Year I Semester).

Each student shall register for and secure the specified number of Credits required for the completion of the PGP and Award of the M.Tech. Degree in respective Branch of Engineering with the chosen Specialization.

I Year is structured to provide typically 18 Credits in each of the I and II Semesters, and II Year 16 credits in each of the III & IV semesters, totaling to 68 Credits for the entire M.Tech. Programme.

**Course Registration:**

A 'Faculty Advisor' shall be assigned to each M.Tech. Programme with respective Specialization, who will advise the Students about the M.Tech. Programme Specialization, its Course Structure and Curriculum, Choice/ Option for Subjects/ Courses, based on the competence, progress, pre-requisites and interest of the students.

A student may be permitted to register for subjects/courses of 'his choice' with a typical total of 18 credits per semester in I year (minimum being 15 credits and maximum being 21 credits, permitted deviation being ± 15%), and 16 credits (inclusive of project) per III semester in (II year) (minimum being 13 credits and maximum being 19 credits), 16 credits (inclusive of project) per IV semester in II year (minimum being 16 credits and maximum 21 credits), based on his interest, competence, progress, and 'pre-requisites' as indicated for various subjects/courses, in the centre course structure (for the relevant specialization) and syllabus contents for various subjects/ courses.

Choice for 'additional Subjects/Courses' in any Semester (above the typical 18/16 Credit norm, and within the Maximum Permissible Limit of 21/21 Credits, during I/ II Years as applicable) must be clearly indicated in the Registration, which needs the specific approval and signature of the Faculty Advisor/Counselor on hard-copy.

Withdrawal of Subjects/ Courses in any Semester of I Year may be permitted, ONLY AFTER obtaining prior approval and signature from the Faculty Advisor (subject to retaining a minimum of 15 Credits), 'within 15 Days of Time' from the beginning of the current Semester.

**Attendance Requirements:**

A Student shall be eligible to appear for the Semester End Examination (SEE) of any Subject, if he acquires a minimum of 75% of attendance in class work in that Subject for that Semester.

A Student's Mini Project with Seminar Report and Mini Project with Seminar Presentation shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in Mini Project with Seminar Presentation Classes during that Semester.

Condoning of shortage of attendance up to 10% (65% and above, and below 75%) in each

Subject ( Theory / Practicals / Mini Project with Seminar/project work, etc.) of a Semester may be granted by the Institute Academic Council on Medical grounds, based on the Student's representation with supporting evidence to be submitted by the student as and when such requirement arise, but not at the end of the semester. Such requests shall not be entertained once the percentage of attendance is calculated and displayed at the end of semester class work.

A stipulated fee per Subject, ( Theory / Practicals / Mini Project with Seminar/Project work etc.) shall be payable towards condoning of shortage of attendance after getting the approval of Institute academic council for the same.

Shortage of Attendance below 65% in any Subject, (Theory / Practicals / Mini Project with Seminar etc.) shall in NO case be condoned.

A Student, whose shortage of attendance is not condoned in any Subject(s) , Lab or Mini Project with Seminar in any Semester, is considered as 'Detained in that Subject(s), Lab or Mini Project with Seminar', and is not eligible to write Semester End Examination

(s) of such Subject(s), Lab (and in case of Mini Project with Seminars, his/her Mini Project with Seminar Report or Presentation are not eligible for evaluation) in that Semester; and he/she has to seek Re-registration for those Subject(s), Lab or Mini Project with Seminar in subsequent Semesters, and attend the same as and when offered.

A student fulfilling the attendance requirement in the present semester shall not be eligible for readmission into the same class.

**Academic Requirements:**

The following Academic Requirements have to be satisfied, in addition to the attendance requirements mentioned in Item No. 6**.** The performance of the candidate in each semester shall be evaluated subject – wise, with a maximum of 100 marks per subject/course (theory /practical), on the basis of Internal Evaluation and Semester End Examination.

A Student shall be deemed to have satisfied the academic requirements and earned the Credits allotted to each Subject/Course, if he/she secures not less than 40% Marks (28 out of 70 Marks) in the Semester End Examination, and a minimum of 50% of marks in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades and this implies securing B Grade or above in that Subject.

A Student shall be deemed to have satisfied the academic requirements and earned the Credits allotted to - Mini Project with Seminar, if he/she secures not less than 50% of the total Marks to be awarded for each of them. The Student would be treated as failed, if he / she - (i) does not present the Mini Project with Seminar as required, or (ii) secures less than 50% of Marks (< 50 Mark) in Mini Project with Seminar. In such case of Mini Project with seminar, he/she has to reappear in the next subsequent semesters, as and when scheduled.

A Student shall - register for all Subjects covering 68 Credits as specified and listed in the Course Structure for the chosen PGP Specialization, put up all the Attendance and Academic requirements for securing 68 Credits obtaining a minimum of B Grade or above in each Subject and 'earn all 68 Credits securing Semester Grade Point Average (SGPA) $\geq$ 6.0 ( in each Semester) and final Cumulative Grade Point Average (CGPA) (ie., CGPA at the end of PGP) $\geq$6.0, to successfully complete the PGP.

**Note: (1) The SGPA will be computed and printed on the marks memo only if the candidate**

**passes in all the subjects offered and gets minimum B grade in all the subjects.**

**(2) CGPA is calculated only when the candidate passes in all the subjects offered in all the semesters**.

Marks and Letter Grades obtained in all those Subjects covering the above specified 68 Credits alone shall be considered for the calculation of final CGPA, which shall be indicated in the Grade Card/Marks Memo of II Year II Semester.

If a student registers for 'extra Subjects' (in the parent Centre or other Departments/ Branches of Engg.) other than those listed Subjects totaling to 68 Credits as specified in the Course Structure, the performances in those 'extra Subjects' (although evaluated and graded using the same procedure as that of the required 68 Credits) will not be taken into account while calculating the SGPA and CGPA. For such 'extra Subjects' registered, % marks and Letter Grade alone will be indicated in the Grade Card/Marks Memo as a performance measure, subject to completion of the Attendance and Academic Requirements as stated in Items 6 and 7.1 – 7.4 above.

Students who fail to earn 68 Credits as per the specified Course Structure, and as indicated above, within 4 academic years from the date of commencement of their I Year I Semester, shall forfeit their seats in M.Tech. Programme and their admissions shall stand cancelled.

When a Student is detained due to shortage of attendance in any Subject (s) (Theory/Practicals/Mini Project with Seminar etc., ) in any Semester, no Grade Allotment will be made for such Subject (s) (Theory/Practicals/Mini Project with Seminar etc.,) and SGPA/ CGPA calculations of that Semester will not include the performance evaluations of such Subject(s) (Theory/Practicals/Mini Project with Seminar etc., ) in which he got detained. However, he / she becomes eligible for re-registration of such Subject (s) (Theory/Practicals/Mini Project with Seminar etc.)/ in the subsequent Semester(s), as and when next offered, with the Academic Regulations of the Batch into which he /she gets re-registered , by paying the stipulated fees per Subject. In all these re-registration cases, the Student shall have to secure a fresh set of Internal Marks (CIE) and Semester End Examination Marks (SEE) for performance evaluation in such Subject(s), and subsequent SGPA/ CGPA calculations.

A Student eligible to appear in the Semester End Examination in any Subject, but absent at it or failed (failing to secure B Grade or above), may reappear for that Subject at the supplementary examination (SEE) as and when conducted. In such cases, his Internal Marks (CIE) assessed earlier for that Subject/ Course will be carried over, and added to the marks to be obtained in the supplementary examination (SEE), for evaluating his performance in that Subject.

**Evaluation - Distribution and Weightage of Marks:**

The performance of a Student in each Semester shall be evaluated Subject-wise (irrespective of Credits assigned) with a maximum of 100 Marks for Theory or Practicals or Mini Project with Seminar etc; however, the M.Tech. Project Work (Major Project) will be evaluated for 200 Marks.

For the theory subjects 70 marks shall be awarded for the performance in the Semester End Examination and 30 marks shall be awarded for Continuous Internal Evaluation (CIE) (25marks for mid exams and 5marks for assignment). The Continuous Internal Evaluation shall be made based on the average of the marks secured in the two Mid-Term

Examinations conducted, first Mid-Term examinations in the middle of the Semesterand second Mid-Term examinations during the last week of instruction. Each Mid-Term Examination shall be conducted for a total duration of 120 minutes with Part 'A' as compulsory consisting of 5 questions carrying 2 marks each (10 marks), and Part 'B' with 3 questions to be answered out of 5 questions, each question carrying 5 marks (15 marks). The details of the Question Paper pattern for Semester End Examination (Theory) are given below:

- The Semester End Examination will be conducted for 70 marks. It consists of two parts. i) Part A for 20 marks, ii) Part B for 50 marks.
- Part A is compulsory and consists of 5 questions, one from each unit and carrying 4 marks each.
- Part B consists of 5 questions carrying 10 marks, each with internal choice. There will be two questions from each unit and only one should be answered.

For Practical Subjects, there shall be a Continuous Internal Evaluation (CIE) during the Semester for 30 Internal Marks, and 70 Marks are assigned for Lab./ Practicals Semester End Examination (SEE). Out of the 30 Marks for Internals, day-to-day work assessment in the laboratory shall be evaluated for 15 Marks; and the performance in an internal Lab/Practical Test shall be evaluated for15 marks. The SEE for Lab./ Practicals shall be conducted at the end of the Semester by the concerned Lab teacher and another faculty member of the same Centre as assigned by the Head of the Department.

There shall be a Mini Project with Seminar Presentation in I Year II Semester, for the Seminar the Student shall collect the information on a specialized topic, prepare a Mini Project Report and submit to the Centre at the time of Mini Project with Seminar Presentation. The Continuous Internal Evaluation (CIE) -30Marks given by the faculty handling the Mini Project with Seminar. Mini Project with Presentation (along with the Mini Project Report) shall be evaluated by Departmental review committee (DRC) consisting of Head of the Department, Mini Project Guide and Senior faculty member assigned by Head of the Department for 70 marks.

**a)** Every student shall be required to do project work.

**b)** The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters.

**c)** **Registration of Project work** : Every Student must compulsorily register for his M.Tech. Project Work, within the 4 weeks after the completion of I year II Semester. After Registration, the Student has to present, in consultation with his Project Guide, the title, objectives and plan of action of his project work to the Project Review Committee (PRC) for approval within 4 weeks from the commencement of Second year First Semester. Only after obtaining the approval of the PRC, the student can initiate the Project work.

**d)** A Project Review Committee (PRC) shall be constituted with the Head of the Centre as Chairperson, Project Guide and one senior faculty member of the Departments offering the M.Tech. programme. (*Committee shall not be less than 3 members and constituted

with the Head of the Centre as Chairperson, Project Supervisor and one senior faculty member of the Centre offering the M. Tech. programme. In case HOD is a supervisor then one more senior faculty member will be included in the committee to maintain not less than 3 members) The PRC will monitor the progress of the Project Work and review, through Project work Review – I and Project work Review –II Presentations – one at the end of the II Year I Semester, and another before the submission of M.Tech. Project Work Report.

**e)** If a candidate wishes to change his Guide or topic of the project, he can do so with the approval of the PRC. However, the PRC shall examine whether or not the change of topic/Guide leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Guide or topic as the case may be.

**f)** A candidate shall submit his project progress report in two stages at least, with a gap of three months between them.

**g)** **The Project Work Review I** in II Year I Semester carries internal marks of 100. Evaluation should be done by the PRC. The PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the dissertation. A candidate has to secure a minimum of 50% of marks to be declared successful in Project Work Review I. If he/she fails to obtain the minimum required marks, he/she has to reappear for Project Work Review-I as and when conducted.

**h) The project work Review II and Viva- voce:**

In II Year II Semester, Project work review II carries 30 internal marks and viva-voce, 70 external marks. The PRC will examine the overall progress of the Project Work during internal evaluation and decide whether the Project is eligible for final submission or not. A candidate has to secure a minimum 50%of marks to be declared successful in project.

**i)** **Project Work Review** I and II shall be conducted in phase I (Regular) and Phase II (Supplementary). Phase II will be conducted only for unsuccessful students in Phase I. The unsuccessful students in Project Work Review I (Phase II, supplementary) shall reappear for it at the time of Project Work Review II (Phase I, regular). The unsuccessful students in project work review II (phase I regular) shall reappear for it at the time of project review II (Phase II supplementary). The unsuccessful students in Phase II of Project work Review II have to reappear for it at the time of Project work review – I in the next academic year only.

**j)** After approval from the PRC, a soft copy of the thesis should be submitted to the Head of the Centre for the ANTIPLAGIARISM check and the Head of the Centre will submit the plagiarism report to the Director of the Institute. The project work report (Dissertation) will be accepted for submission, if the similarity index is less than **30%**. If the similarity index has more than the required percentage, the student is advised to modify accordingly and re-submit the soft copy of the Dissertation after one month. The maximum number of re-submissions of Dissertation after plagiarism check is limited to TWO. After three attempts, the admission is liable to be cancelled.

**k)** The Student shall be allowed to submit his Project Dissertation, only on the successful completion of all the prescribed PG Subjects (Theory and Practical's.), Mini Project with Seminar, etc. (securing B Grade or above), and after obtaining all

approvals from PRC.

**l)** Before the submission of the Dissertation students are encouraged to submit a Research Paper related to Project Work in a UGC approved journal (students are encouraged to publish the work in peer reviewed journals). A copy of the submitted research paper may be attached to the project report Dissertation. Three copies of the Project Dissertation certified by the Guide shall be submitted to the Head of the Department.

**m)** The project report Dissertation will be adjudicated by an external examiner selected by the Institute. For this the Head of the Centre shall submit a panel of three examiners from among the list of experts in the relevant specialization as submitted with the help of supervisor concerned. In such cases, the M.Tech. Dissertations will be sent to an External Examiner nominated by the Director of the Institute, on whose 'approval', the Student can appear for the M.Tech. Project Viva-voce Examination, which shall be conducted by a Board, consisting of the PG Project Supervisor, Head of the Department, and the External Examiner who adjudicated the M.Tech. Project Work / Dissertation. The Board shall jointly declare the Project Work Performance as 'satisfactory', or 'unsatisfactory'; and in successful cases, the External Examiner shall evaluate the Student's Project Work presentation and performance for 70 Marks .

**n)** If the report of the external examiner is unsatisfactory, the candidate shall revise and resubmit the Thesis after ONE semester, or as per the time specified by the External examiner. If the resubmitted report is again evaluated by the external examiner and examiner is unsatisfactory again then the Dissertation shall be summarily rejected. No further correspondence in this matter will be entertained, if there is no specific recommendation for resubmission by the external examiner.

**o)** If the report of the examiner is satisfactory, the Head of the Centre shall coordinate and make arrangements for the conduct of Project Viva- Voce examination. The Project Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Centreand the external examiner who adjudicated the Dissertation. The candidate has to secure a minimum of 50% of marks in Project Evaluation (Viva-Voce) examination.

**p)** If he /she fails to fulfill the requirements as specified in 8.6 (n), he will reappear for the Viva-Voce examination only after three months. In the reappeared examination also, if he/she fails to fulfill the requirements, he/ she will not be eligible for the award of the degree, unless he/she is asked to revise and resubmit his project work by the board within a specified time period (within four years from the date of commencement of his first year first semester).

**q)** If the candidates oral presentation is not satisfactory, the board may defer it and the candidate has to re-appear for the oral presentation before the same board for the award of degree.

**r)** The Project Viva-Voce External examination marks must be submitted to the Institute on the day of the examination.

**Re-Admission / Re-Registration:**

**Re-Admission for Discontinued Students:**

Students, who have discontinued the M.Tech. Degree Programme due to any reasons what so ever, may be considered for 'Readmission' into the same Degree Programme (with same specialization) with the Academic Regulations of the Batch into which she/he gets readmitted, with prior permission from the concerned authorities, subject to Item 4.1.

**Re-Registration for Detained Students:**

When any Student is detained in a Subject (Theory / Practical / Seminar etc. ) due to shortage of attendance in any Semester, he/she may be permitted to re-register for the same Subject in the 'same category' (Core or Elective Group) or equivalent Subject if the same Subject is not available, as suggested by the Board of Studies of that Department, as when offered in the sub-sequent Semester(s), with the Academic Regulations of the Batch into which he seeks re-registration , with prior permission from the concerned authorities, subject to Item 4.1.

**Examinations and Assessment – The Grading System**

Marks will be awarded to indicate the performance of each student in each Theory Subject, or Practical, or Mini Project with Seminar, Project, etc., based on the % marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item 6 above, and a corresponding Letter Grade shall be given.

As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

| *% of Marks Secured in a subject/Course(Class Intervals)* | *Letter Grade (UGC Guidelines)* | *Grade Points* |
|---|---|---|
| *Greater than or equal to 90%* | *O (Outstanding)* | *10* |
| *≥80 and less than 90%* | *A+ (Excellent)* | *9* |
| *≥70% and less than 80%* | *A (Very Good)* | *8* |
| *≥60% and less than 70%* | *B+ (Good)* | *7* |
| *≥50% and less than 60%* | *B (Average)* | *6* |
| *Below 50%* | *F (FAIL)* | *0* |
| ***Absent*** | ***Ab*** | ***0*** |

A student obtaining F Grade in any Subject shall be considered 'failed' and is be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when conduct. In such cases, his/her Internal Marks (CIE Marks) in those Subjects will remain the same as those he obtained earlier.

If a student does not appear for the examinations, 'Absent' Grade will be allocated to

him for any subject and shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted.

A Letter Grade does not imply any specific % of Marks, it is only the range of percentage of marks.

In general, a student shall not be permitted to repeat any subject / course (s) only for the sake of 'Grade Improvement' or 'SGPA/CGPA Improvement.

A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course (excluding Mandatory non-credit Courses). Then the corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Subject/ Course.

**Credit Points (CP) = Grade Point (GP) x Credits …. For a Course**

The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (ΣCP) secured from ALL Subjects/ Courses registered in a Semester, by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as

**SGPA = { $\sum_{i=1}^{N} C_i G_i$ } / { $\sum_{i=1}^{N} C_i$} …. For each Semester**,

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N' is the no. of Subjects 'REGISTERED' for the Semester (as specifically required and listed under the Course Structure of the parent Department), is the no. of Credits allotted to the $i^{th}$ Subject, and represents the Grade Points (GP) corresponding to the Letter Grade awarded for that $i^{th}$ Subject.

**Illustration of calculation of SGPA**

| Course / Subject | Credits | Letter Grade | Grade Point | Credit Points |
|---|---|---|---|---|
| Course 1 | 3 | A | 8 | 3*8=24 |
| Course 2 | 3 | O | 10 | 3*10=30 |
| Course 3 | 4 | B+ | 7 | 4*7=28 |
| Course 4 | 3 | B | 6 | 3*6=18 |
| Course 5 | 2 | A+ | 9 | 2*9=18 |
| Course 6 | 1.5 | B | 6 | 1.5*6=9 |
| Course 7 | 1.5 | O | 10 | 1.5*10=15 |
| | 18 | | | 142 |

**SGPA**=142/18=7.89

The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the I Year second Semester onwards, at the end of each Semester, as per the formula

**CGPA = { $\sum_{j=1}^{M} C_j G_j$ } / { $\sum_{j=1}^{M} C_j$ } … for all S Semesters registered**

**(i.e., up to and inclusive of S Semesters, S ≥1)**,

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of the parent Department) the Student has 'REGISTERED' from the 1st Semester onwards upto and inclusive of the Semester S ( obviously M > N ), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), $C_j$ is the no. of Credits allotted to the $j^{th}$ Subject, and $G_j$ represents the Grade Points (GP) corresponding to the Letter Grade awarded for that $j^{th}$ Subject. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

**Illustration of calculation of CGPA**

| Semester | Credits | SGPA | Credits * SGPA |
|---|---|---|---|
| Semester I | 18 | 7 | 18*7=126 |
| Semester II | 18 | 6 | 18*6=108 |
| Semester III | 16 | 6.5 | 16*6.5=104 |
| Semester IV | 16 | 8 | 16*8=128 |
| | 68 | | 466 |

**CGPA** =466/68 =6.85

For Merit Ranking or Comparison Purposes or any other listing, ONLY the 'ROUNDED OFF' values of the CGPAs will be used. For Calculations listed in Item 10.7 – 10.10, performance in failed Subjects/ Courses (securing F Grade) will also be taken into account, and the Credits of such Subjects/ Courses will also be included in the multiplications and summations. However, Mandatory Courses (Audit Course) will not be taken into consideration.

A student shall be declared successful or 'passed' in a Semester, only when he/she gets a SGPA ≥6.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire PGP, only when gets a CGPA ≥6.00; subject to the condition that he/she secures a GP ≥6 (B Grade or above) in every registered Subject/ Course in each Semester (during the entire PGP) for the Award of Degree as required.

**Passing Standards:**

A Student shall be declared successful or 'passed' in a Semester, only when he/she gets a SGPA ≥6.00 (at the end of that particular Semester); and a Student shall be declared successful or 'passed' in the entire PGP, only when gets a CGPA ≥6.00; subject to the condition that he secures a GP ≥6 (B Grade or above) in every registered Subject/ Course in each Semester (during the entire PGP), for the Award of the Degree, as required.

10.14.2 After the completion of each Semester, a Grade Card or Grade Sheet (or Transcript) shall be issued to all the Registered Students of that Semester, indicating the Letter Grades and Credits earned. It will show the details of the Courses Registered (Course Code, Title, No. of Credits, Grade Earned), Credits earned SGPA and CGPA etc.

**Declaration of Results:**
Computation of SGPA and CGPA are done using the procedure listed in 10.7 – 10.10.

For Final % of Marks equivalent to the computed CGPA, the following formula may be used.

**% of Marks = (CGPA – 0.5) x 10**

## 10.0 Award of Degree and Class:

A Student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme (PGP), and secures the required number of **68** Credits (with GP ≥6.0), shall be declared to have 'QUALIFIED' for the award of the M.Tech. Degree in the chosen Branch of Engineering and Technology with specialization as he/she was admitted.A Student with final CGPA (at the end of the PGP)< 6.00 will not be eligible for the Award of Degree.

## 11.0 Withholding of Results:

If a Student has not paid fees to University/ Institute at any stage, or has pending dues against his name due to any reason whatsoever, or if any case of indiscipline is pending against him, the result of the Student may be withheld, and he/she will not be allowed to go into the next higher Semester. The Award or issue of the Degree may also be withheld in such cases.

## 12.0 Transitory Regulations:

A Student - who has discontinued for any reason, or who has been detained for want of attendance as specified, or who has failed after having undergone PGP, may be considered eligible for readmission to the same PGP with same set of Subjects/ Courses (or equivalent Subjects/ Courses as the case may be), and same Professional Electives (or from same set/category of Electives or equivalents as suggested), as and when they are offered (within the time-frame of 4 years from the Date of Commencement of his I Year I Semester).

## 13.0 Student Transfers:

There shall be no Branch/ Specialization transfers after the completion of Admission Process.

**Scope:**

I. Where the words "he", "him", "his", occur in the write-up of regulations, they include "she", "her", "hers".
II. Where the words "Subject" or "Subjects", occur in these regulations, they also imply "Course" or "Courses".
III. The Academic Regulations should be read as a whole, for the purpose of any interpretation.
IV. In case of any doubt or ambiguity in the interpretation of the above regulations, the decision of the Vice-Chancellor/ Director is final.
V. The Institute may change or amend the Academic Regulations, and/ or Course Structure, and/ or Syllabi at any time, and the changes or amendments made shall be applicable to all Students with effect from the dates as notified by the University/ Institute.

## 14.0 MALPRACTICES RULES:

| | Nature of Malpractices | Punishment |
|---|---|---|
| | **If the candidate:** | |
| 1 (a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination) | Expulsion from the examination hall and cancellation of the performance in that subject only. |
| 1 (b) | Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell<br>Phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2 | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year.<br>The Hall Ticket of the candidate is to be cancelled. |
| 3 | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practical's and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in |

| | | |
|---|---|---|
| | | connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him. |
| 4 | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5 | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject. |
| 6 | Refuses to obey the orders of the Chief Superintendent / Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the Institute campus or engages in any other act which in the opinion of the officer on duty amounts to use | In case of students of the Institute, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. |

| | | |
|---|---|---|
| | of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | |
| 7 | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8 | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. |
| 9 | If student of the Institute, who is not a candidate for the particular examination or any person not connected with the Institute indulges in any malpractice or improper conduct mentioned in clause 6 to 8. | Student of the Institute expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the Institute will be handed over to police and, a 8police case will be registered against them. |
| 10 | Comes in a drunken condition to the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. |

| | | |
|---|---|---|
| 11 | Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny. | Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester / year examinations. |
| 12 | If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Institute for further action to award suitable punishment. | |

**GENERAL:**

- **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- **Credit Point:** It is the product of grade point and number of credits for a course.
- The Academic Regulations should be read as a whole for the purpose of any interpretation.
- The University/Institute reserves the right of altering the Academic Regulations and/or Syllabus/Course Structure, as and when necessary. The modifications or amendments may be applicable to all the candidates on rolls, as specified by the University/Institute.
- Wherever the words 'he' or 'him' or 'his' occur in the above regulations, they will also include 'she' or 'her' or 'hers'.
- Wherever the word 'Subject' occurs in the above regulations, it implies the 'Theory Subject', 'Practical Subject' or 'Lab.' and 'Seminar'.
- In case of any ambiguity or doubt in the interpretations of the above regulations, the decision of the Director will be final.

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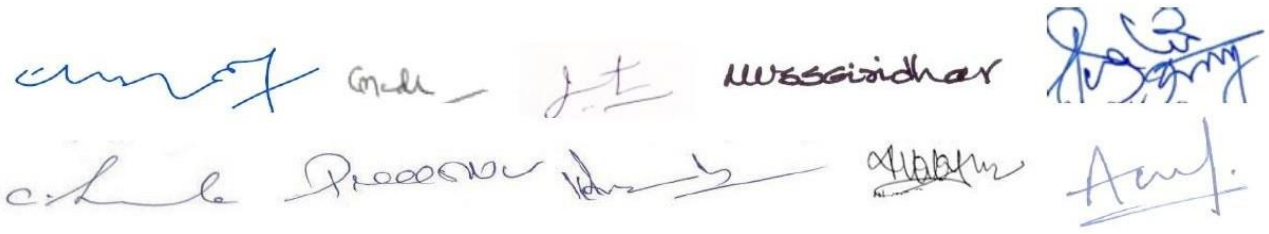
# COURSE STRUCTURE

## SEMESTER-I

| Course Number | Subject | Scheme Of Studies Per Week | | | Credits | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|
| | | L | T | P | | | |
| **1WETPC01** | **Program Core – I**<br>Surface Water Hydrology | 3 | 0 | 0 | 3 | 30 | **70** |
| **1WETPC02** | **Program Core – II**<br>Ground Water Hydrology | 3 | 0 | 0 | 3 | 30 | **70** |
| **1WETPE03** | **Program Electives- I**<br>• Advanced Fluid Mechanics<br>• Water Quality Modeling and Management<br>• Finite Elements in Water Resources Engineering | 3 | 0 | 0 | 3 | 30 | **70** |
| **1WETPE04** | **Program Electives- II**<br>• Water Resources Systems Analysis<br>• River Basin Management<br>• Water Distribution System<br>• Industrial Waste Water Treatment<br>• WEB GIS<br>• Environmental Engineering-I | 3 | 0 | 0 | 3 | 30 | **70** |
| **1A01** | **Research Methodology & Intellectual Property Rights** | 2 | 0 | 0 | 2 | 30 | **70** |
| **1A02** | **Audit course-I** | 2 | 0 | 0 | 0 | 0 | **0** |
| **1WETL05** | **Lab- I**<br>Hydraulics and Hydrology Laboratory | 0 | 0 | 4 | 2 | 30 | **70** |
| **1WETL06** | **Lab- II**<br>Environmental Laboratory | 0 | 0 | 4 | 2 | 30 | **70** |
| **TOTAL** | | **16** | **0** | **08** | **18** | **210** | **490** |

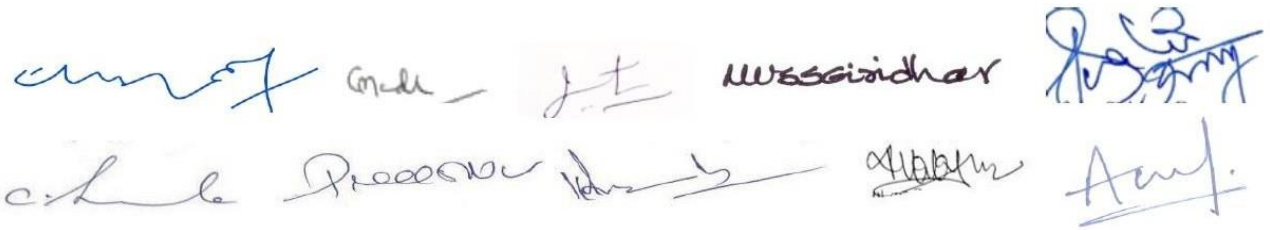
**Signatures of BoS Members**



**SEMESTER-9**

| Course Number | Subject | Scheme Of Studies Per Week | | | Credits | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|
| | | L | T | P | | | |
| **2WETPC07** | **Program Core – III**<br>Geospatial Applications in Water Resources | 3 | 0 | 0 | 3 | 30 | **70** |
| **2WETPC08** | **Program Core – IV**<br>• Irrigation Engineering | 3 | 0 | 0 | 3 | 30 | **70** |
| **2WETPE09** | **Program Electives- III**<br>• Fluvial Hydraulics<br>• Urban Hydrology<br>• River Engineering<br>• Environmental Impact Assessment | 3 | 0 | 0 | 3 | 30 | **70** |
| **2WETPE10** | **Program Electives- IV**<br>• Sustainable Water Resources Development<br>• Climate Change Adaptation and Mitigation<br>• Environmental Engineering-II<br>• Python Script Programming | 3 | 0 | 0 | 3 | 30 | **70** |
| **2A03** | **Audit Course-II** | 2 | 0 | 0 | 0 | 00 | **00** |
| **2WETL11** | **Lab- III**<br>GIS and Image Processing Laboratory | 0 | 0 | 4 | 2 | 30 | **70** |
| **2WETL12** | **Lab - IV**<br>Water Resources Modeling Laboratory | 0 | 0 | 4 | 2 | 30 | **70** |
| **2WET13** | **Mini project with Seminar** | 2 | 0 | 0 | 2 | 30 | **70** |
| **TOTAL** | | **16** | **0** | **08** | **18** | **210** | **490** |

**Signatures of BoS Members**



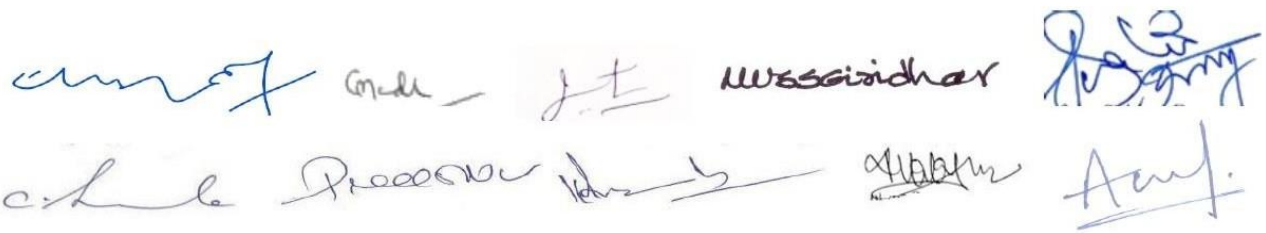
**SEMESTER-III**

| Course Number | Subject | Scheme Of Studies Per Week | | | Credits | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|
| | | L | T | P | | | |
| **3WETPE14** | **Program Elective- V**<br>• Application of Soft Computing Techniques<br>• Advanced Numerical Methods<br>• Solid and Hazardous Waste Management<br>• Hydro Power Engineering<br>• Micro Irrigation Technologies<br>• Design of Hydraulic structures<br>• WEB Development | **3** | **0** | **0** | **3** | **30** | **70** |
| **3WETOE15** | **Open Elective**<br>• Business Analytics<br>• Industrial Safety<br>• Operations Research<br>• Cost Management of Engineering Projects<br>• Composite Materials<br>• Waste to Energy<br>• Environmental Statistics | **3** | **0** | **0** | **3** | **30** | **70** |
| | **Dissertation – I** | | | | | | |
| | **a) Dissertation Work Review-I** | | | **0** | **0** | **0** | **0** |
| **3WET16** | **b) Dissertation Work Review -II** | **0** | **0** | **20** | **10** | **100** | **0** |
| **TOTAL** | | **06** | **0** | **20** | **16** | **160** | **140** |

**SEMESTER-IV**

| Course Number | Subject | Scheme Of Studies Per Week | | | Credits | Internal Marks | External Marks |
|---|---|---|---|---|---|---|---|
| | | L | T | P | | | |
| **4WET17** | **Dissertation II**<br>**Project Work Review - III** | 0 | 0 | 32 | 16 | 30 | **70** |
| **Total** | | **0** | **0** | **32** | **16** | **30** | **70** |

**Signatures of BoS Members**



**CENTRE FOR WATER RESOURCES**

**INSTITUTE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)**
**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD**
**COURSE STRUCTURE AND SYLLABUS (CBCS) -2021**
**R21 Course structure scheme for M. Tech 2021-23**
**M.TECH (Water and Environmental Technology - Regular)**

## SEMESTER-I

PROGRAMME CORE-I / 1WETPC01

## SURFACE WATER HYDROLOGY

**OBJECTIVES:**

- The students acquire knowledge about hydrologic cycle, precipitation its measurement and analysis along with its abstractions
- Students understand infiltration, constitution of stream flow and hydrographs
- The students understand floods, analysis, routing along with its mitigation and management
- It creates awareness regarding surface water pollution ,causes, prevention and remedial measures
- The students are made to understand different disasters and its management. In addition, they study about climate change, drought and water harvesting

**UNIT-I: Components of Hydrologic Cycle**: Hydrologic Cycle, Precipitation, Cloud Seeding, Rain Gauge Net Work, Estimation of Missing Rainfall Data, Mean Precipitation Over an Area by Arithmetic Mean, Thiessen Polygon and Isohyetal Methods, Checks of Rainfall Data, Double Mass Curve, Evaporation, Transpiration, Methods of Estimation of Evapotranspiration, Inter basin transfer of water, inter boundary, interlinking of rivers, trans boundary, peninsular/ Himalayan component.

**UNIT-II: Initial Abstractions & Hydrograph Analysis:** Infiltration, Factors affecting Infiltration, Measurement of Infiltration, Infiltration Curve and Infiltration Indices. Runoff: Stream flow Hydrograph, Hydrograph Separation, Unit Hydrograph.

**UNIT-III: Hydrology of Floods:** Definition: Hydrology of Floods: Causes of Floods, Flood Discharge Formulae and Envelope Curves, Flood Frequency Analysis, Flood Control- Flood Control Dams, Detention Basins, Levees, Diversion Channels, Flood Channel Improvement Schemes. Flood Routing: Routing Through a Reservoir by I.S.D. Method, Channel Routing by Muskingum Method.

**UNIT-IV: Surface Water pollution:** Introduction, Causes of Water Pollution, their Effects, Remedial Measures, Pattern of Pollution, Self Purification Processes in Streams. Raw and Treated Water Quality Monitoring and Surveillance Including Various Standards.

**UNIT-V: Disaster Management:** Types of Natural Disasters and Manmade Disasters, Effects of Drought, Combating Drought, Reducing Runoff Losses, Reducing Evaporation and Deep Percolation, Efficient use of Stored Soil Water, Early Warning Systems, Evacuation Plans and Post Disaster Management and Administration, Climate change and its impact on Water Resources, Overview of rainwater harvesting.

**COURSE OUTCOMES**

The student is expected to

**CO1:** To learn about precipitation and its measurement, analysis and interpretation.
**CO2:** Know about abstractions to rainfall, infiltration, evaporation and transpiration along with their estimation and derivation of unit hydrograph from hydrograph.
**CO3:** Gain Knowledge about floods, its estimation, combat floods and flood routing.
**CO4:** Familiarize with surface water pollution, causes, effects and remedial measures.
**CO5:** Acquire knowledge about disasters and its management, conservation of water and climate change and its impact on water resources.

**TEXT BOOKS:**


- Water Resources Engineering by Larry W.Mays, John Wiley & Sons, Inc.& 2010.
- A Text Book on Hydrology by P.Jayarami Reddy, Laxmi publishers, 2011.
- A text book on Hydrology by H.M.Raghunadh, New age international publishers, 2015


**REFERENCE BOOKS:**


- Water and Environment by U.Aswathanarayana, A.A. Balkema Publishers, 2001
- Hydrology and Water Resources Engg by K.C.Parti, Narosa Publishers, 2001.
- Water Resources-Environment Planning& development by A.K.Biswas, Tata McGraw Hill, 1997.
- Hydrology Water Quantity & Quality control,by Wanisliste & Elenlin, John Wiley, 1997.
- Applied Hydrology by Ven Te Chow, David R.Maidenment & Larry W.Mays, McGraw-Hill, 1988.

PROGRAMME CORE-II/1WETPC02

## GROUND WATER HYDROLOGY

**OBJECTIVES:**

- To understand the fundamentals concepts of groundwater concepts for its storage movement governing laws with field and laboratory estimation of hydraulic properties.
- To learn flow of water porous medium its governing equations and estimation of aquifer parameters with various types of pumping tests in tube wells and open wells.
- To learn ground water exploration techniques by using geophysical methods such as electrical resistivity methods and seismic refraction method.
- To learn various ground water management techniques such as artificial recharge, conjunctive use basin management and control of sea water intrusion.
- To understand the ground water pollution, remediation and modeling of the aquifer with respect flow model and transport model.

**UNIT-I: Fundamental Concepts:** Types of Aquifers, Vertical Distribution of Soil Water below the Ground, Porosity, Specific Yield, Hydraulic Conductivity and Storage Coefficient, their Practical Significance, Darcy's Law and its Validity, Ground Water Flow Contours and their Applications, Tracer Techniques in Ground Water Flow Studies.

**UNIT-II: Ground Water Hydraulics:** Derivation of Basic Differential Equation and its Solutions, Steady and Unsteady Radial Flow of Ground Water towards a Well in Confined and Unconfined Aquifers, Analysis of Pumping Test Data, Theis type Curve Method, Jacob's Method for Time and Distance Draw Down Tests, Open Well Hydraulics, Recuperation Test.

**UNIT-III: Groundwater Exploration:** Remote sensing, hydro geological methods, Electrical Methods, Expression for Apparent Resistivity in Four Electrode Arrangements viz. – Werner, Schlumberger Arrays, Field Surveys, Interpretation Techniques in Sounding, Profiling and Imaging for Ground Water Investigation, Seismic Refraction Method – Principle and Propagation of Refracted Energy in Two and Three Media Earth, Field Procedure and Interpretation Techniques, Ground Penetrating Radar - principle - field procedure and Interpretation, well logging.

**UNIT-IV: Ground Water Management:** Water Balance Studies, Perennial Yield, Concept of artificial recharge, Various types of artificial recharge techniques, Conjunctive use of surface and groundwater, Management of coastal aquifers – Ghyben Herzberg relation, upcoming of Saline Water, Methods of control of salt-water intrusion. Application of environmental isotopes in GW studies. Success stories such as JNTUH campus, Telangana groundwater department in artificial recharge - field visits.

**UNIT-V: Ground Water Pollution and Modeling:** Ground Water Quality, Ground Water Pollution, Elements and Source of Pollution, their Effects and Remedial Measures. Aquifer Modeling: Electrical Analog Models, RC Network Techniques, Principles of Digital Modeling of Aquifers, Flow Modeling Using Finite Difference Methods and Finite Element Methods, Advection Process, Diffusion and Dispersion Process, Solute Transport Modeling, Sampling and hydro chemical characteristics of GW - Case Studies

**COURSE OUTCOMES**

The student is expected to

**CO1:** To understanding the fundamentals concepts of groundwater for its storage movement governing laws with field and laboratory estimation of hydraulic properties.

**CO2:** Derivation of flow of Water through porous media its governing equations and estimation of aquifer parameters with various types of pumping tests in tube wells and open wells.

**CO3:** Application of ground water exploration techniques by using geophysical methods such as electrical resistivity methods and seismic refraction method to explore groundwater.

**CO4:** Practicing various groundwater management techniques such as artificial recharge, conjunctive use basin management and control of sea water intrusion.

**CO5:** To understand the groundwater pollution, remediation and modeling of the aquifer with respect to flow model and transport model.

**TEXT BOOKS:**


- Ground Water Hydrology by D.K. Todd, John Wiley & Sons, 1976.
- Ground water Hydrology by H.M.Raghunath, Wiley Eastern Limited, 1986.
- Numerical Ground Water Hydrology by A.K.Rasthogi, Penram International Publishing, 2007
- Groundwater Assessment, Development and Management by K.R.Karanth, Tata Mc.Graw Hill 1987.


**REFERENCE BOOKS:**


- Concepts and Models in Groundwater Hydrology by P.A.Domenico.McGraw-Hill Inc, 1972.
- Regional Ground Water Modelling by M. Thangarajan, Capital Publishing Co., 2004.
- Ground Water Resources Evaluation by W.C.Walton, Mc Graw Hill, 1976.
- Geohydrology by Davis, S.N. and De Weist, R.J.M.1966. John Wiley and sons, inc.
- Hydrogeology of Telangana State by Dr.Pandith Madhnure, Ground Water Department, August 2021, Pg.1-127

PROGRAMME ELECTIVE –I/ 1WETPE03

## ADVANCED FLUID MECHANICS

**OBJECTIVES:**

- To understand basic knowledge about fluid properties.
- To learn and apply fluid statics for solving fluid problems.
- To acquire the fluid kinematics knowledge for solving fluid kinematics problems in fluid mechanics.
- To understand and solve problems on dynamics of ideal and real fluids.
- To understand concepts of boundary layer theory and apply in boundary layer flows.

**UNIT-I: Fluid Properties and Fluid Statics:** Density, Specific weight, Specific gravity, viscosity, Vapor pressure, compressibility, Pressure at a point, Pascal's law, pressure variation with temperature, density and attitude. Hydrostatic law, Piezometer, Simple and differential manometers, pressure gauges, total pressure and center of pressure plane, vertical and inclined surfaces.

**UNIT-II: Fluid Kinematics:** Mathematical Descriptions of Fluid Motion, Classification of Flows, Stream line, path line, streak line, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, one, two and three dimensional flows Continuity equation in 3D flow, stream function, velocity potential function.

**UNIT-III: Dynamics of Ideal Fluids:** Three Dimensional Continuity and Energy Equations For Steady Incompressible Flow, Applications to Simple One Dimensional Problems, Impulse-Momentum Equations for Steady Incompressible Flow, Problems of Pipe Bend, Flow through Venturimeters and Orificemeter, Pitot tube.

**UNIT-IV: Dynamics of Real Fluids:** Navier Stokes Equations, Flow between Parallel Plates, Hagen Poiseuille flow, Karman- Prandtl Equations for Velocity Distribution.

**UNIT-V: Boundary Layer Flows:** Boundary layer definitions and characteristics, displacement thickness, momentum thickness and energy thickness, expressions for Boundary Layer Thicknesses, Prandtl's Boundary Layer Equations, Laminar and Turbulent Boundary Layer Equations, Boundary Layer Separation and its control.

**COURSE OUTCOMES**

The student is expected to

**CO1:** Inculcate knowledge on description of fluid motion, stream and velocity potential, their properties and applications.

**CO2:** Develop understanding on the dynamics of Ideal fluids, applications to one dimension problems and evaluate the problems on pipe bend, venturimeter and orifice meter.

**CO3:** Imbibe the equations of real fluids like Navier Stokes equation, Stokes flow and Hagen Poiseuille flow.

**CO4:** Acquire knowledge on boundary layer flow for various expressions and equation on laminar and turbulent boundary, Integral momentum and boundary layer separation.

**CO5:** Grasp the basic idea of turbulence in fluid flow.

**TEXT BOOKS:**

1. Fluid Mechanics by F.M. White, Mc Graw Hill, 2005.
2. Fluid Mechanics by victor L.Streeter, Mc Graw Hill 1985.
3. Fluid Mechanics and machinery by D.Rama Durgaiah, New age international (p) ltd.,publishers 2002.

**REFERENCE BOOKS:**

1. Mechanics of Fluids by B.S.Massey, Chapman and Hall 1994.

PROGRAMME ELECTIVE –I/ 1WETPE03

## WATER QUALITY MODELLING AND MANAGEMENT

**OBJECTIVES:**

- To know concepts of water quality.
- To know about sources of water and estuaries.
- To know about modeling and transport processes
- To know about contaminant transport models.
- To understand about water quality management.

**UNIT-I:Water Quality Parameters:** Water quality description, various characteristics of water, water quality criteria and standards, elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transport mechanism-advection, diffusion, dispersion.

**UNIT-II:Surface Water Quality:** River and streams, convective diffusion equation and its application. Estuaries, Estuarine hydraulics, Estuarine water quality models; Lakes and reservoirs, eutrophication.

**UNIT-III:Mathematical modeling of environmental systems:** Numerical/mathematical modeling of environmental systems, subsystems, and pollutant transport processes Contaminant transport in unsaturated flows, solute transport models for conservative species, solute transport in spatially variable soils.

**UNIT-IV:Contaminant transports:** Contaminant transports in ground water advection, dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, bio degradation reaction.Groundwater hydrographs.

**UNIT-V:Water quality management:** Water quality management, socio-economic aspects of water quality management, management alternatives for water quality control, waste load allocation process, lake quality management, and groundwater remediation.

**COURSE OUTCOMES**

The student is expected to

CO1: Become familiar with water quality standards, contamination of water along with contaminant transport mechanism.

CO2: Know about sources of water, water quality models and eutrophication.

CO3: Gain knowledge about solute transport models and contaminant transport in unsaturated flows.

CO4: Learn about different mechanisms like advection, dispersion and different models like dual porosity model and numerical models.

CO5: Acquire knowledge about water quality management, control including groundwater remediation

**TEXT BOOKS:**


- Anu Ramaswami, Jana B Milford , Michell J.Small, Integrated Environmental Modeling - Pollutant Transport, Fate, and Risk in the Environment John Wiley & Sons, 2005.
- Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems, Oxford University Press, 1998.
- Snape J.B., Dunn I.J.,Ingham J., and Prenosil J., Dynamics of environmental bioprocesses, modelling and simulation Weinheim: VCH, 1995.


**REFERENCE BOOKS:**


- International Water Association - Activated sludge modelling ASM1 and ASM2
- Chapra S. C., Surface Water Quality Modeling, McGraw-Hil, Inc., New York, 1997.
- Garde R. J., and Ranga Raju K. G., Mechanics of sediment transportation and alluvial stream problems, Third edition, New Age International (P) Limited, New Delhi
- Thomann, R.V. and Mueller, J.A. Principles of surface water quality modeling and control, Pearson, 1987
- Chapra, S.C. Surface water quality modelling, Waveland Press, INC., 1997
- Schnoor, J.L., Environmental Modeling Wiley, John & Sons, 1997
- Thomann, R.V., Systems Analysis and Water Quality Management, McGraw Hill, 1972

PROGRAMME ELECTIVE –I/ 1WETPE03

**FINITE ELEMENTS IN WATER RESOURCES ENGINEERING**

## OBJECTIVES:

- To understand basics of finite elements as applicable in the water resources area and fluids

**MODULE-I**

Introduction; Finite Element Method, Concepts of elements and nodes, degrees of freedom. Relation between nodal degrees of freedom and generalized coordinates, convergence requirements, natural coordinate systems, shape functions, element stiffness matrix.

Basic Concepts of FEA: Advantages, Disadvantages and Limitations of FEA, Errors and Accuracy of FEA. Basic steps in finite element analysis

**MODULE- II**

Isoparametric elements: Computation of stiffness matrix for isoparametricelements, direct stiffness method of analysis and solution technique, assemblage of elements, direct stiffness method, boundary conditions and reaction.

Analysis of framed structures; Two dimensional truss element, two dimensional beam element, stiffness matrix for a two dimensional beam element with 6 d.o.f., element load vector, transformation matrix, computation of stress resultants, shear deformation, plane stress and plane strain analysis, nodal load vector, rectangular elements, 8 noded rectangle, isoparametric elements

**MODULE- III**

Applications of FEM: Finite Element Formulation: Displacement based finite element formulation, Pressure based finite element formulation.

Steady State Flow: Introduction, Galerkin`s Method, Triangular elements, Assembly of conductance matrix, Boundary conditions. Region near a well example, Seepage through Dam, Poisson's equation.

Transient Flow: Introduction, Galerkin`s Method, Rectangular elements, Assembly of matrix differential equations, Solving the matrix differential equations, Boundary conditions Reservoir Problem.

Advective-Dispersive Transport: Introduction, Dispersion, Solute transport equation, Solute dispersion in uniform flow field.

**Text/Reference Books:**


1. C.S.Krishnamoorthy, " Finite element analysis, theory and programming", Tata McGraw Hill
2. Cook R.D., Malkus, D.S. and Plesha, M.E., Concepts and Applications of Finite Element Analysis, Third Edition, John Wiley.
3. O.C. Zienkiewicz, The Finite Element Method, Tata McGraw-Hill.
4. Pinder, G. F., Gray, W. G., Finite Elements in Subsurface Hydrology, Academic Press, 1977.
5. Huyakorn, P.S and Pinder, C. F., Computational Methods in Sub-Surface Flow, Academic Press, 1983.
6. Connor, J.C. and Brebbia, C. A., Finite Element Techniques for Fluid Flow, Butterworth, 1976.
7. Taylor, C. and Hughes, T. J. Finite Element programming of the NavierSotckes Equation, Pinerdge Press, 1980.
8. Finlayson, B. A., The method of Weighted Residuals and Variational Principles, Academic Press, 1972.
9. Wang H.F and Anderson M P, Introduction to Groundwater Modelling, Academic Press 1982.


**Course Outcomes:**

Upon successful completion of course the students will be able to:

1. Ability to know about ordinary and partial differential equations and finite difference methods
2. Ability to know application of various hydrodynamic techniques to steady and unsteady flows
3. Ability to know application of finite element method to steady and unsteady flows
4. Ability to perform computer programming of these computational methods

PROGRAMME ELECTIVE –II/ 1WETPE04

## WATER RESOURCES SYSTEMS ANALYSIS

**OBJECTIVES:**

- To understand the concepts of water resources planning and management and the role of optimization models
- The various methods of linear programming are discussed in this unit.
- The application of dynamic programming for resource allocation and goal programming are dealt in this unit.
- Gradient based research techniques and simulation concepts are discussed here.
- In this unit the economics and management of water resources are understand in detail.

**UNIT-I: Introduction:** concepts of systems analysis, definition, systems approach to water resources planning and management, role of optimization models, objective function and constraints, types of optimization techniques.

**UNIT-II: Linear Programming:** Formulation linear programming models, graphical method, simplex method, application of linear programming in water resources, Revised simplex method, duality in linear programming, sensitivity and past optimality analysis.

**UNIT-III: Dynamics Programming:** Belman's of principles of optimality forward and backward recursive dynamic programming, case of dimensionality, application of dynamic for resource allocation, goal programming.

**UNIT-IV: Non-Linear Optimatization Techniques:** Clerical of method optimization, Kuch-Tucleer, gradential based research techniques for simple unconstrained optimization and Simulation, application of simulation techniques in water resources.

**UNIT-V: Water –Resources Economics and Management:** Principles of Economics analysis benefit cost analysis socio economic intuitional and pricing of water resources. Planning of reservoir system, optimal operation of single reservoir system, allocation of water resources, optimal cropping pattern, conjunctive use of surface and sub-surface water resources.

**COURSE OUTCOMES:**

The student is expected to

CO1: To develop objective function and constraints for various water resources optimization problems.

CO2: To develop linear programming models for water resources problems by using graphical and simplex and revised simplex techniques, to carry out sensitivity analysis and post optimality analysis.

CO3: To develop and solve forward and backward recursive dynamic programming models.

CO4: To understand optimization and simulation concepts and modeling and also apply simulation techniques in water resources problems.

CO5: To understand the fundamentals of economic theory as applied to water resources.

**TEXT BOOKS:**

- Introduction to operation research – Tata Mc. Grawhill Publications, 2005.
- Water Resources System Analysis – S.Vedula & P.P.Mujumdar, 2016.

**REFERENCE BOOKS:**

- Water Resources Economics – L.D.James & R.Lee, McGraw-Hill Inc., 1971.
- Water System by Warren A. *Hall* & John A. *Dracup,* McGraw-Hill Inc.1970.
- Water Resources project Economic by Kuiper.E, Newnes-Butterworth, 1971.
- Water resources system planning and management, by Chaturvedi, M.C., McGraw Hill Education India Pvt Ltd, 1998.

PROGRAMME ELECTIVE –II/ 1WETPE04

## RIVER BASIN MANAGEMENT

**OBJECTIVES:**

1. To discuss different aspects of water resource development and management.
2. To understand the concepts of River reach routing and reservoir routing.
3. To discuss about irrigation distribution systems, water conservation and technological innovation.
4. To learn about allocation of water to drinking, irrigation, hydropower and flood control.
5. To understand the theory of soil erosion and reservoir sedimentation.

**UNIT-I: Management of Multiple System Objectives:** Water Supply, Flood Control, Navigation, Recreation, Fish and Wildlife Habitats, Hydropower Production.

**UNIT-II:Parameters Involved:** River Gauging-Measured and Forecasted Flows, River Reach-Routing the Flow and Calculation of Gains and Losses, River Confluences-Mass Balance at River Confluences, Reservoirs - Storage Reservoirs, Power Reservoirs, Reservoir Routing, Groundwater Storage, Canals, Aggregation of Water Users, etc.

**UNIT-III: Management of Irrigation Structures:** Reservoirs, Irrigation Canal and Distribution Systems, Regulatory Structures, Regulatory Measures, Economic Instruments, Behavioral Changes, Water Conservation, Technological Innovation.

**UNIT-IV: Water Allocations:** Drinking Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, river basin organizations, functions and powers.

**UNIT-V: Soil Erosion & Sedimentation:** Theory of soil erosion, sediment transport, reservoir sedimentation, control measures, catchment treatment.Annual sediment yield estimation from a basin, catchment treatment, control measures, dam safety, dredging reservoirs, dam break analysis

**COURSE OUTCOMES**

The student is expected to

**CO1:** To learn know about forecast of river flows, routing the flow and river confluences.

**CO2:** To understand river confluences and its balance, reservoir routing and aggregation of water users.

**CO3:** Be familiar with management of different irrigation structures, water conservation and concerned technological innovations.

**CO4:** Have thorough understanding of judicious water allocation for various purposes and reservoir operation.

**CO5:** Gain knowledge about soil erosion and sedimentation, control measures and catchment treatment.

**TEXT BOOKS:**

1. Water Resources Management and the Environment by U. Aswathanarayana, A.A. Balkema, the Netherlands, 2001.
2. Water Resources and Land-use Planning:A systems Approach by P. Laconte and Y.V. Haimes (eds.), Martinus Nijhoff Publishers, the Hague, 1982.

**REFERENCE BOOKS:**

- Mechanics of Sediment Transport and Alluvial Stream Problems by Garde, R.J. and Rangaraju, K.G., Wiley Eastern Limited, 1979.
- Flow through Open Channels by Ranga Raju, K.G., Tata McGraw-Hill, 1981.

PROGRAMME ELECTIVE –II/ 1WETPE04

## WATER DISTRIBUTION SYSTEMS

**OBJECTIVES:**

1. Introduction to Water Distribution Networks
2. Methods for Analysis
3. Types of Analysis
4. Methods for Designs

**UNIT-I:** General Hydraulic Principles, Head loss formulae- Darcy-Weisbach formula, Hazen – Williams formula, Modified Hazen-Williams formula, Series and Parallel connection of Pipes, Equivalent Pipes, Analysis of branched Water Distribution Networks.

**UNIT-II:** Formulation of Equations for looped Water Distribution Networks, Analysis of flow in looped networks using Hardy Cross, Newton-Raphson and Linear Theory method, Introduction of Gradient method and other methods of analysis.

**UNIT-III:** Reservoirs, Pumps and Valves (check valve, flow control valve and pressure reduces valve) in Water distribution systems. Flow dependent analysis of multi-reservoir systems, Introduction to head-dependent analysis.
Node flow analysis of water distribution networks: Node head–flow relationships, Direct and Indirect methods, Application of NFA technique to serial networks.

**UNIT-IV:** Optimal and Economical diameter of pumping main, Design of pumping main considering diameter as continuous as well as discrete variable. Water hammer consideration. Design of water distribution networks using Critical Path Method, Formulation of optimization model, Application of Cost-head loss ratio method and Linear Programming Technique to optimal design of branched networks.

**UNIT-V:** Determining number of branching configuration for a looped network, Use of path concept and minimum spanning tree concept, Application of critical path method for design of looped networks. Introduction to methods for Looped WDNs.

**REFERRENCE:**

1. Bhave, P. R. and Gupta R., Analysis of Water Distribution Networks, Narosa Publishing Co, New Delhi.
2. Bhave P. R., Optimal Design of Water Distribution Networks Narosa Publishing Co, New Delhi.
3. Jeppson R.W., Analysis of flow in pipe networks, Ann Arbon Science, Michigan USA.
4. Walksi T-M, Analysis of water distribution System Van Nostand Reinheld G, New York USA, 1984.
5. CPHEEO, Manual on Water Supply and Treatment, Ministry of Urban Development G0I.

PROGRAMME ELECTIVE –II/ 1WETPE04

## INDUSTRIAL WASTE WATER TREATMENT

**OBJECTIVES:**

The course will address the following:

1. Enables the student to distinguish between the quality of domestic and industrial water requirements and wastewater quantity generation.
2. To impart knowledge on selection of treatment methods for industrial wastewater.
3. To know the common methods of treatment in different industries
4. To acquire knowledge on operational problems of effluent treatment plant.

**UNIT – I**

Industrial water Quantity and Quality requirements: Boiler, Cooling, Domestic/Canteen andProcess waters for Textiles, Food processing, Dairy, Aqua industry, Sugar mills, Brewery anddistillery Industries, Fertilizer industry, Power plants. Advanced water treatment -Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron andManganese, Removal of Colour and Odour. Use of Municipal wastewater in Industries.

**UNIT – II**

Basic theories of Industrial Wastewater Management: Industrial waste survey -Measurement of industrial wastewater Flow-generation rates – Industrial wastewater sampling and preservation of samples for analysis - Wastewater characterization- Toxicity of industrial effluents- Common methods of Treatment of wastewaters - Unit operations and processes- Volume and Strength reduction –Neutralization – Equalization and proportioning- recycling, reuse and resources recovery. Miscellaneous Treatment: Biological treatment of sewage- Primary, secondary and Tertiary treatment of sewage.

**UNIT – III**

Industrial wastewater disposal management: Discharges into Sewers, Streams- Oxygen sag curve, Lakes-eutrophication and oceans and associated problems, Land treatment – sewage sickness, Common Effluent Treatment Plants: advantages and suitability, Limitations and challenges- Recirculation of Industrial Wastewaters- Effluent Disposal Method.

**UNIT – IV**

Process and Treatment of specific Industries-1: Manufacturing Process and origin, characteristics, effects and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants. Case studies.

**UNIT – V**

Process and Treatment of specific Industries-2: Manufacturing Process and origin, characteristics, effects and treatment methods of liquid waste from Tanneries, Sugar Mills, Distillers, Dairy and Food Processing industries, Aqua industry, Pharmaceutical Plants. Case studies.

**TEXT BOOKS**:

1. Industrial Wastewater Treatment by KVSG Murali Krishna, Paramount Publishers, Visakhapatnam, 2019
2. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, NewDelhi.
3. Industrial Wastewater treatment by A.D. Patwardhan, PHI Learning,Delhi
4. Wastewater Treatment for Pollution Control and Reuse, by Soli. J Arceivala, Shyam R Asolekar, Mc-Graw Hill, New Delhi; 3rdEdition

**REFERENCES:**

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition
2. Wastewater Engineering by Metcalf and EddyInc, Tata McGrawhillCo., New Delhi
3. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India.
4. Unit Operations and Processes in Environmental Engineering by Reynolds. Richard, Cengage Learning.

PROGRAMME ELECTIVE –II/ 1WETPE04

## WEB GIS

**OBJECTIVES:**

1. To know Fundamentals of Web.
2. To know about Java Script.
3. To know about Programming in Web GIS
4. To have exposure to handling Geographical Data in Internet Environment
5. To understand about Publishing the Geo-spatial data

**UNIT I:** Fundamentals of Web: Introduction to web & Mark up languages, Different tags of HTML, Marquee List, frames ,I-frames and creation of form document, CSS: Block level and Inline elements, Types of style sheets, Box model, Different fonts, Animation, Static layout.

**UNIY II:** Java Script for Form validation: Introduction to java script: Syntax, Statements, Comments, Popup Boxes: Alert, Confirm, Prompt, Variables, Operators, Conditional Statements, Loops, Events, Cookies. Page Printing, Page redirection, Built-in Objects, Debugging, HTML DOM.

**UNIT III:** Programming in Web GIS: Introduction to different 2D and 3D view, working with Map views, Constructors, Map view properties and methods.

**UNIT IV:** Display Geographical Data in Internet Environment: Base maps, Map Rendering ,Query task, Point graphics, Working with base map tools, Feature Layer Query, Geometric engine.

**UNIT V:** Publishing the Geo-spatial data: Search widget, Publishing of Geospatial data in Local server and Global server, Geo-coding, Validating and Analyzing the results.

**COURSE OUTCOMES:**

The student will be able to

CO1: Comprehend basic programming including HTML & CSS to implement high quality web mapping applications.

CO2: Familiarize with the usage of Java Script for form validation of web page

CO3: Gain an understanding of the basic concepts of programming using web GIS

CO4: Have the basic knowledge of techniques to distribute, process and display geographical data in the Internet environment, and

CO5: Develop the skill for publishing the geospatial data

**TEXT BOOKS:**

1. An Introduction to Web design and programming, McGraw Hill, Wang, Thomson.
2. Ajax: The Complete Reference – Thomas A. Powel, McGraw Hill, 2008.
3. JavaScript 2.0 Complete Reference, 2nd Edition by Thomas A. Powel, McGraw Hill.

PROGRAMME ELECTIVE –II/ 1WETPE04

## ENVIRONMENTAL ENGINEERING-I

**OBJECTIVES:**

- Outline planning and the design of water supply systems for a community/town/city
- Provide knowledge of water quantity requirements and methods of piping
- Impart understanding of importance of protection of water source quality and methods of treatment of converting raw water into product water of required quality
- Design of water treatment plant for a village/city
- Impart knowledge on design of water distribution network

**UNIT–I Introduction:** Importance and Necessity of Protected Water Supply systems, Water borne diseases, Flow chart of public water supply system, Role of Environmental Engineer. Evolution of water supply system. Water Demand and Quantity Estimation: Estimation of water demand for a town or city, Per capita Demand and factors influencing it - Types of water demands and its variations- factors affecting water demand, Design Period, Factors affecting the Design period, Population forecasting.

**UNIT-II Sources of Water:** Lakes, Rivers, Impounding Reservoirs, comparison of sources with reference to quality, quantity and other considerations- Capacity of storage reservoirs, Mass curve analysis. Groundwater sources of water: Types of water bearing formations, springs, Wells and Infiltration galleries, Yields from infiltration galleries. Collection and Conveyance of Water: Factors governing the selection of the intake structure, Types of Intakes. Conveyance of Water: Gravity and Pressure conduits, Types of Pipes, Pipe Materials, Pipe joints, Design aspects of pipe lines, laying of pipelines

**UNIT-III Quality and Analysis of Water:** Characteristics of water– Physical, Chemical and Biological. Analysis of Water – Physical, Chemical and Biological characteristics. Comparison of sources with reference to quality- IS 10500 2012 and WHO guidelines for drinking water - Water quality standards for Agriculture, Industries and Construction

**UNIT–IV Treatment of Water:** Treatment methods: Theory and Design of Sedimentation, Coagulation, Sedimentation with Coagulation, Filtration Disinfection: Theory of disinfection-Chlorination and other Disinfection methods, Softening of Water, Removal of color and odors- Removal of Iron and Manganese - Adsorption- Fluoridation and deflouridation– Aeration–Reverse Osmosis- Ion exchange– Ultra filtration

**UNIT–V Distribution of Water:** Requirements- Methods of Distribution system, Layouts of Distribution networks, Pressures in the distribution layouts, Analysis of Distribution networks: Hardy Cross and equivalent pipe methods - Components of Distribution system: valves such as sluice valves, air valves, scour valves and check valves, hydrants, and water meters– Laying and testing of pipe lines- selection of pipe materials, pipe joints. Ideal water supply system. Case studies.

**COURSE OUTCOMES**

The Student is expected to

- Estimation of design population and water demand
- Identify the water source and select proper intake structure
- Characterization of water for drinking, industry and construction
- Design of water treatment plant for a village/city
- Selection and design of an ideal distribution system

**TEXT BOOKS:**


- Rural, Municipal and Industrial Water Management, KVSG Murali Krishna, Reem Publications, New Delhi, 2012
- Elements of Environmental Engineering – K. N. Duggal, S. Chand & Company Ltd., New Delhi, 2012.


**REFERENCE BOOKS:**


- Environmental Engineering – Howard S. Peavy, Donald R. Rowe, George Tchobanoglus – McGraw-Hill Book Company, New Delhi,1985.
- Water Supply Engineering – P. N. Modi.
- Water Supply Engineering – B. C. Punmia
- Water Supply and Sanitary Engineering – G. S. Birdie and J. S. Birdie 5. Environmental Engineering, D. Srinivasan, PHI Learning Private Limited, New Delhi, 2011.

CORE/ 1A01

## RESEARCH METHODOLOGY AND IPR

**UNIT 1:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT 2:** Effective literature studies approaches, analysis Plagiarism, Research ethics.

**UNIT 3:** Effective technical writing, how to write report, Paper

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT 4:** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**UNIT 5:** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

**UNIT 6:** New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**COURSE OUTCOMES:**

Students will be able to

CO1: Understand research problem formulation.
CO2: Analyze research related information
CO3: Follow research ethics
CO4: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO5: Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO6: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**TEXT BOOKS:**


- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students, Kenwyn, South Africa: Juta & Co., 1996.
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2014.


**REFERENCE BOOKS:**


- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
- Mayall, W.H. "Industrial Design", McGraw Hill, 1992.
- Niebel, Benjamin W., "Product Design", McGraw Hill, 1974.
- Morris Asimow, "Introduction to Design", Englewood Cliffs, N.J., Prentice-Hall [1962]
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

AUDIT COURSE -1/ 1A02

## ENGLISH FOR RESEARCH PAPER WRITING

**UNIT –I:** Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

**UNIT-II**: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

**UNIT-III:** Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

**UNIT-IV:** Key skills are needed when writing a Title; key skills are needed when writing abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

**UNIT-V:** Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

**UNIT-VI:** Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

### COURSE OUTCOMES:

Students will be able to:

CO1: Understand that how to improve your writing skills and level of readability
CO2: Learn about what to write in each section
CO3: Understand the skills needed when writing a Title
CO4: Ensure the good quality of paper at very first-time submission

### SUGGESTED STUDIES:


- Goldbort R (2006) Writing for Science, Yale University Press (available on GoogleBooks)
- Day R (2006) How to Write and Publish a Scientific Paper, Cambridge UniversityPress
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
- Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

AUDIT COURSE -1/ 1A02

## DISASTER MANAGEMENT

**UNIT-1: Introduction:** Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT-II: Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.
Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

**UNIT-III:Disaster Prone Areas in India:** Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

**UNIT-IV:Disaster Preparedness and Management: Preparedness:** Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And CommunityPreparedness.

**UNIT-V: Risk Assessment: Disaster Risk:** Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies forSurvival.

**UNIT-VI: Disaster Mitigation:** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation, Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation inIndia.

**COURSE OUTCOMES:**

Students will be able to:

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarianresponse.
CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflictsituations.
CO4: Critically understand the strengths and weaknesses of disaster managementapproaches, planning and programming in different countries, particularly their home country or the countries they work in

**SUGGESTED READINGS:**


- R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal bookCompany, 2007.
- Sahni, PardeepEt. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, NewDelhi, 2010.
- Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., NewDelhi, 2007.

AUDIT COURSE -1/ 1A02

## SANSKRIT FOR TECHNICAL KNOWLEDGE

**OBJECTIVES:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in theworld.
- Learning of Sanskrit to improve brainfunctioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memorypower.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancientliterature.

**UNIT-I:**

- Alphabets inSanskrit,
- Past/Present/FutureTense,
- Simple Sentences

**UNIT-II:**

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

**UNIT-III:**

- Technical concepts of Engineering-Electrical, Mechanical, Architecture,Mathematics

**COURSE OUTCOMES:**

Students will be able to

CO1: Understand basic Sanskritlanguage.
CO2: Understand Ancient Sanskrit literature about science & technology.
CO3: Develop logic instudents being a logical language.

**SUGGESTED READING**


- "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, NewDelhi
- "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New DelhiPublication
- "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., NewDelhi.

AUDIT COURSE -1/ 1A02

## VALUE EDUCATION

**OBJECTIVES:**

- Understand value of education and self-development
- Imbibe good values instudents
- Let the should know about the importance ofcharacter

**UNIT-I:**

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision ofhumanism.
- Moral and non- moral valuation. Standards andprinciples.
- Valuejudgments.

**UNIT-II:**

- Importance of cultivation ofvalues.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness,Cleanliness.
- Honesty, Humanity. Power of faith, NationalUnity.
- Patriotism, Love for nature, Discipline.

**UNIT-III:**

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity anddiscipline.
- Punctuality, Love andKindness.
- Avoid faultThinking.
- Free from anger, Dignity of labor.
- Universal brotherhood and religioustolerance.
- Truefriendship.
- Happiness Vs suffering, love fortruth.
- Aware of self-destructivehabits.
- Association andCooperation.
- Doing best for savingnature

**UNIT-IV:**

- Character and Competence –Holy books vs Blind faith.
- Self-management and Goodhealth.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role ofWomen.
- All religions and samemessage.
- Mind your Mind,Self-control.
- Honesty, Studyingeffectively

**COURSEOUTCOMES:**

Students will be able to

CO1: Gain knowledge of self-development
CO2: Learn the importance of Human values
CO3: Develop the overallpersonality

LAB 27/ 1WETL05

## HYDRAULICS AND HYDROLOGY LABORATORY

**OBJECTIVES:**

1. To prepare and analyze ground water contour map.
2. To estimate the resistivity and thickness of various layers by conducting vertical electrical sounding.
3. To know the lateral & vertical homogeneity of earth by conducting seismic refraction & resistivity imaging.
4. To know about lift, drag, pressure distribution and surface profiles.
5. To know about the characteristic curves and frictional losses.

### List of Practical's

- Preparation of Groundwater contour map.
- To determine the Resistivity and Thickness of various sub-surface layers vertically below the central point using Schlumberger method (One Dimensional)
- To create Resistivity image by using ABEM SAS 1000 Terrameter (Two Dimensional)
- To determine the thickness of the sub-surface layers by conducting Seismic Refraction method
- To determine sub-surface layers resistivity, fluid resistivity and spontaneous potential by using by using ABEM SAS 300 Well Logger (Sub-surface method), vertical section of bore well
- To investigate underground shallow and deeper pipelines and to understand the various anomalies in the sub-surface by using Ground Penetrating Radar with 100 MHz and 400 MHz antennas
- To determine the aquifer characteristics such as Transmissivity (T) and Storage Coefficient (S) by conducting pumping tests
- To study the pressure distribution on Aerofoil and Cylindrical model.
- To study the Lift and Drag on Aerofoil.
- To study the characteristics curves for Wind Tunnel.
- To compare the theoretical and actual pressures at cavitation condition.
- To verify Darcy's Law.
- To find out the coefficient of Permeability of a given medium.
- To determine the coefficient discharge for Rota meter at different fluorides.
- To plot the surface profile of a forced vortex and free vortex by measurement of the surface profile coordinates.
- To find out the depth of flow along the test length of the flume
- To plot a specific energy curve for a constant discharge.
- To study and calibrate the Pitot static tube.
- To determine the frictional head loss between reservoir and surge tower.
- To measure open channel flow using IOT technologies

**COURSE OUTCOMES**

Students are expected to

CO1: Explore the groundwater using electrical resistivity and seismic methods.
CO2: Identify civil utility using Ground Penetrating Radar.
CO3: Determine of aquifer characters using pumping tests and well logging techniques.
CO4: Study the characteristics curves and specific energy curves.
CO5: Determine the frictional losses, coefficient of discharge and surface profiles coordinates.

LAB 2/ 1WETL06

## ENVIRONMENTAL LABORATORY

**OBJECTIVES:**

- The physical, chemical parameters of the water and wastewater samples are analyzed in the laboratory.
- The significance of the results is compared with the Bureau of Indian standards.

### List of Practicals

- To determine the presence of Total Suspended solids in the given wastewater sample.
- To determine the amount of Total dissolved solids present in the given wastewater sample.
- To estimate the concentration of nitrates present in the Groundwater and Surface water Samples.
- To estimate the chlorides concentration in the given Groundwater and Surface water Samples.
- To estimate the concentration of Sulfates present in the given Groundwater and Surface water Samples.
- To determine the Alkalinity of the given Groundwater and Surface water Samples.
- To determine the Total Hardness for Groundwater Sample and Surface water Sample.
- To determine the Calcium and Magnesium Hardness of Groundwater Sample and Surface water Sample.
- To estimate the Fluorides concentration in the given Groundwater and Surface water Samples.
- To estimate the dissolved oxygen content present in the given Groundwater and Surface water samples.
- To estimate the phosphates concentration in the given Groundwater and Surface water Samples.
- To estimate the biological oxygen demand present in the given Groundwater, Surface water and wastewater samples.
- To estimate the chemical oxygen demand present in the given Groundwater, Surface water and wastewater samples.
- To determine the heavy metals present in the given Groundwater, Surface water and wastewater samples.
- To determine the total organic carbon present in the given wastewater sample.
- To determine the E coli and fecal coliform bacteria present in the given wastewater sample
- Field trips to STPs

**COURSE OUTCOMES**

Students will be able to

CO1: Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.
CO2: Statistically analyze and interpret laboratorial results.
CO3: Understand and use the water and wastewater sampling procedures and sample preservations.
CO4: Demonstrate the ability to write clear technical laboratorial reports.
CO5: Understand the impact of biological parameters on wastewater.

**SEMESTER-II**

PROGRAMME CORE-III/2WETPC07

## GEOSPATIAL APPLICATIONS IN WATER RESOURCES

**OBJECTIVES:**

- To understand basic concepts of remote sensing for its applications in the area of water resources
- To acquire knowledge on geographical information systems
- To get the concepts and applications of data acquisition and data input for water resources project
- To get the basic and applied knowledge on how to use global positioning systems
- To understand the applications of remote sensing and geographical information systems in the field of water and environmental technology

**UNIT-I: Basic Concepts and Foundation of Remote Sensing:** Elements involved in Remote Sensing, Electromagnetic spectrum, Remote Sensing Terminology, Energy Sources, Energy Interactions with Earth Surface Features and Atmosphere, Resolution, Sensors and Satellites, Visual Interpretation Techniques-Basic Elements, Interpretation for Terrain Evaluation, Spectral Properties of Water Bodies

**UNIT-II: Geographical Information Systems(GIS):** Introduction, GIS Definition and Terminology, GIS Categories, Components of GIS, Fundamental Operations of GIS, A theoretical Framework for GIS, GIS Types of Data Representation, Raster Data Structures, Vector Data Structures, Comparisons between Data Structures.

**UNIT-III: Data Acquisition and Data Input:** Introduction, Existing Data Sets, Developing Own Data, Digitization and Scanning, Preprocessing- Format Conversion, Data Reduction and Generalization, Error Detection and Editing, Merging, Edge Matching, Rectification and Registration, Interpolation.

**UNIT-IV: Global Positioning System (GPS):** Introduction, background, the space segment, the control segment, and the user segment, the performance of GPS- factors influencing GPS accuracy, GPS positioning. Base line data computation, Coordinate change and satellite positions, GPS receivers, Fundamentals of GPS application for various results, broad view of GPS applications. DGPS – real time experience of DGPS.

**UNIT V: Remote Sensing & GIS Applications:** Land Use/Land Cover in Water Resources, Rainfall-Runoff Modeling, Flood Plain Zoning, Drought Assessment and Monitoring, Cropping Patterns, Condition of Crops, Estimation of Sediment Load, Application to groundwater.

**COURSE OUTCOMES**

The Student is expected to

CO1: Develop the knowledge on basic concepts of remote sensing, elements involved in remote sensing, its energy sources and interaction with earth's surface features and foundations of remote sensing.

CO2: Comprehend the concepts of Geographical Information System (GIS), components of GIS, types and data structures.

CO3: Understand how the data sets are acquired and developed, and can carry out the preprocessing of data inputs.

CO4: Improve the learning on global positioning system (GPS), factors influencing GPS, GPS signal characteristics, mathematical model and GPS applications.

CO5: Identify the importance of Remote sensing and GIS in various applications like water resources, drought assessment, flood plain zoning etc.

**TEXT BOOKS:**

- Remote Sensing and Image Interpretation by T.M. Lillesand & R.W. Kifer, 2015.
- GIS by Michel Dimmar.
- A text Book of RS &GIS by M.Anji Reddy, BS Publishers, Rpt. 2019.

**REFERENCE BOOKS:**

1. Introduction to Remote Sensing, 5th edition, by Campbell Guilford press, 2011
2. Remote Sensing by Kevin white, ELBS Publishers, 1990.
3. Fundamentals of Remote Sensing by Joseph, 2nd Universities Press, 2005.
4. GIS an Introduction by Nadine schuwrman, Blackwell publishers, 2004.
5. Use of GIS in practical Hydrology by Mcijroff *et al*, ITC Netherlands, 1995.
6. Application of remote sensing to hydrology including groundwater by Farsworth, R.K., Bawetl, E.C. & Dhanju, M.S., IHP, UNESCO, 1984.

PROGRAMME CORE-IV/2WETPC08

## IRRIGATION ENGINEERING

**OBJECTIVES:**

1. To know the fundamentals of soils physical & chemical properties with respect to soil water plant relationship.
2. To learn to estimate water requirement of various principal crops.
3. To learn the design and development of various irrigation methods.
4. To know survey and design of land grading, conveyance of water through field channels and through underground pipe lines.
5. To learn salt problems in irrigated areas and design of drainage systems.

**UNIT-1: Introduction:** Irrigation Development in India, Necessity, Scope, and Benefits of Irrigation, Types of Irrigation, Physical and Chemical properties of soils, Texture and structure of Soils, Soil groups of India, Soil Water plant Relations in Irrigation, Measurement of Soil Moisture, Field Capacity, Temporary and Permanent Wilting Points, Hydraulic Conductivity, Water movement through soils.

**UNIT-II: Water Requirement of Crops:** Meteorological Parameters needed in estimating water requirement of crops, Their measurements, Methods for estimating Evapotranspiration of crops, Consumptive Use, Irrigation Requirement of Principal Crops, Duty, Delta and Base Period and Inter-relationships, Factors Affecting the Duty, Cropping Patterns, Irrigation Efficiencies.

**UNIT-III: Methods of Irrigation:** Surface Irrigation Methods, Border, Check, Furrow, Sub-irrigation Methods and their Relative Merits, Principles of Design of Surface Irrigation Methods, Micro- Irrigation, Sprinkler and Drip Irrigation Methods and their advantages and disadvantages, Design principles and Methods for Evaluation, Concepts of Hydroponics, Aeroponics and precision farming.Lift irrigation

**UNIT-IV: Land Grading and Field Layout:** Criteria for Land Leveling, Land Grading Survey and Design, Equipment of Land Grading, Field Layout suiting different crops. Conveyance of Irrigation Water, Field Channels, Different lining materials, Design of field channels, Drop structures, Conveyance of water through underground pipe lines.

**UNIT-V: Drainage of Irrigated Lands:** Salt problems in Soil and Water,Water logging in irrigated areas, Causes, Methods for Controlling water logging, Drainage, Surface and Subsurface Drainage Systems, Suitability of these methods, Design of Drainage Systems, Reclamation and Management of Salt Affected Soils.

**TEXT BOOKS:**


- Irrigation: Theory and Practice by Michael. A.M 2nd Edition, Vikas Publishing House, 2009.
- Land and Water Management Engineering by V.V.N. Murthy, Kalyani Publishers, 2008.
- Irrigation –Theory and Practice" by Withers and Vipond, S, Cornell University Press, 1980.


**REFERENCE BOOKS:**


- Soil and Water Management Systems by Scwabe G.O., Fangmeir, D.D. and Elliot W.J, John Wiley & Sons, 1996.
- Irrigation, Drainage and Salinity by Hutchinson, Hutchinson & Company (Publishers) Ltd.1975.
- Irrigation and Water Resources Engineering by Asawa,G.L ,New age Publishers,2005.
- Irrigation Principles and Practice by Hansen, V.E., Israelson, O.S. and Stringham G.C., John Wiley & Sons, N York 1963.

PROGRAMME ELECTIVE-III/2WETPE09

## FLUVIAL HYDRAULICS

**OBJECTIVES:**

- To acquire basic concepts of free surface flow and its distribution along with applications of various basic equations.
- To understand the concepts of gradually varied flow for steady state condition.
- To understand the concepts of gradually rapid flow for steady state condition.
- To get the knowledge on non-dimensional members and applications to hydraulic models.
- To acquire the concepts and basic design rules for design of stable channels.

**UNIT-I: Basic Concepts of Free Surface Flow:** Basic Principles of Free Surface Flow, Types of Channels, Flow Regimes, Velocity Equations, Most Economic sections, Uniform Flow Computations, Velocity and Pressure Distribution, Energy Principles and its Applications, Specific Energy, Critical Depth, Critical Flow Computations, Momentum Equation and its Applications, Specific force Diagram.

**UNIT-II: Steady Gradually Varied Flow:** Dynamic Equation, Characteristics of Flow Profiles, Practical Problems, Gradually Varied Flow Analysis and Computation.

**UNIT-III: Steady Rapidly Varied Flow:** Hydraulic Jump, Types of hydraulic jump, Hydraulic jump Analysis, Length of the jump, Expression for energy loss during the jump, Jump in Sloping Channels. Unsteady Rapidly Varied Flow- Dam Break Problem, Moving Hydraulic Jump, Positive and Negative Surges.

**UNIT-IV: Hydraulic similitude:** Dimensions and dimensional homogeneity, Rayleigh's method, Buckingham's pi- theorem method, Froude's, Reynolds, Mach's and Weber's laws of similitude, simple applications to hydraulic models, Distorted models, Scale effect.

**UNIT-V: Design of stable Channels:** Design of Unlined channels in alluvial transporting canals by Kennedy's and Lacey's theories.

**COURSE OUTCOMES**

The student is expected to

CO1: To learn about types of flows and flow profiles, varied flow analysis and computation.
CO2: Understand dam break analysis, formation of jump on sloping channels, surges and its types.
CO3: Know about different methods of dimensional analysis and its applications.
CO4: Gain knowledge about different dimensionless members and their model laws and flow fields in which they are applicable, kinds of similarity and types of models and scale effect.
CO5: Be thorough with design of alluvial channels, different theories and their relative merits and demerits.

**TEXT BOOKS:**

1. Open Channel Hydraulics by Chow,. V.T., Mc Graw Hill Inc. N York, 2009.
2. Open Channel Flow by Henderson, Mc Millan Pub. London, 1996.
3. Flow in Open Channels by Subramanya, K, Tata Mc Graw Hill Pub., 2009.

**REFERENCE BOOKS:**

- Mechanics of Sediment Transportation and Alluvial Stream Problems by Garde and Ranga Raju, K.G. Wiley Eastern, N Delhi, 1980.
- Open –Channel Flow by Chaudhry M.H, Prentice Hall of India, N Delhi, 1994.
- Open Channel Hydraulics by French, R.H. Mc Graw Hill Pub Co., N York, 1986.
- Open Channel Flow by M.Hanif Chaudhry, Elsevier Publishers, 2006.

PROGRAMME ELECTIVE-III/2WETPE09

## URBAN HYDROLOGY

**OBJECTIVES:**

1. The students understand urban hydrological cycle, impact of urbanization on quality of water and erosion due to urban runoff.
2. It gives an idea about probabilistic and statistical approaches, data collection and analysis of storm water.
3. The students learn urban drainage systems and design considerations for sewers.
4. The students understand the storm water management and mitigation of urban storm runoff.
5. The students are expected to learn maintenance of urban drainage systems and regulations.

**UNIT- I: Urban Hydrologic Process:** Process of urbanization, Water in Urban ecosystem, Urban water subsystems, Urban hydrologic cycle, Impact of urbanization on urban runoff and stream flow quantity, Impact of urbanization on quality of runoff and stream flow, Erosion due to urban runoff.

**UNIT- II: Storm water Modeling:** Analysis of hydrologic changes due to urbanization, Approaches to study, Data collection and analysis, Probabilistic and statistical approaches, Principles of storm water modeling.Theme park of metro water works.

**UNIT- III: Urban Drainage Systems**: Sanitary and combined sewer systems, components, Design considerations for fixing sewer capacity, Infiltration into and ex-filtration from sewers, causes, Infiltration inflow analysis, Field investigations, Control measures.

**UNIT- IV**: **Storm Water Management**: Urban storm runoff quantity and quality management, Mitigation of damaging effects of urban storm runoff. Storm water management practices as per CPHEEO manual.

**UNIT-V: Urban Drainage Systems Maintenance:** Maintenance management of UDS and its subsystems, Drainage system, Storm drain conveyance system, Pump stations, Open channel illicit connections and discharges, Spill response, Other considerations, limitations and regulations.

**COURSE OUTCOMES**

The student is expected to

CO1: To know about impact of urbanization on urban runoff urban water sub systems, urban hydrologic cycle.

CO2: Learn modeling of storm water, probabilistic and statistical approaches of analysis of storm water data.

CO3: Understand urban drainage systems, sewers, components, design considerations, infiltration and exfiltration in sewers, field investigations and control measures.

CO4: Be well acquainted with storm water management, monitoring run off, quantity and quality, measures to mitigate damaging effects of urban storm runoff.

CO5: Be familiar with maintenance of urban drainage systems, pump stations, illicit connections, limitations and regulations.

**TEXT BOOKS:**


- Stephenson. D, "Storm Water Hydrology and Drainage", Elsevier Publications, 2nd Edition, 1981.
- Hall.M.J, "Urban Hydrology", Elsevier Applied Science Publishing Company, 1st Edition, 1984.


**REFERENCE BOOKS**


- Overtens D.E., and Medows M.E., "Storm water Modeling" Academic Press, 2nd Edition. 1976.
- Grigg, N.S, "Urban Water Infrastructure Planning, Management, and Operations", John Wiley & Sons, 2nd Edition, 1986.
- Viessman W.I., Knapp J.W., Lewis G.L., and Henbrough, T.E., "Introduction to Hydrology" 1988.

PROGRAMME ELECTIVE-III/2WETPE09

## RIVER ENGINEERING

**OBJECTIVES:**

1. To understand flow regimes in river flows
2. To find out sediment loads from river

**UNIT-I:** Origin and properties of sediments: Nature of sediment problems, origin and formation of sediments , properties of sediments , incipient motion of sediment particles , tractive force approach, cohesive materials.

**UNIT-II:** Regimes of flow: Description of regimes of flow, ripple, dune, antidote, prediction of regimes of flow. Resistance to flow & velocity distribution in alluvial streams: velocity distribution in turbulent flow over rough boundaries, resistance and velocity distribution in alluvial streams.

**UNIT-III:** Bed load transport & saltation: Bed load equations, bed load equations based upon dimensional considerations and semi-theoretical equations, general comments on bed load equations, saltation.

**UNIT-IV:** Suspended load transport: Mechanism of suspension, equation of diffusion, sediment distribution equation, relations for suspended load, wash load , transport of suspended sediment.

**UNIT-V:** Total load transport: sediment samplers design of canals carrying sediment laiden water Types of sediment samplers, Design of channels carrying sediment laiden water, Sediment transport through pipes

REFERENCE BOOKS:

1. Garde R J and RangaRaju K G, Mechanics of Sediment Transportation and Alluvial Stream Problems Wiley Eastern Ltd., 1985.
2. Yang C.T., Sediment Transport- Theory and Practice The McGraw Hill Companies Inc. 1996.
3. Chang H.H., Fluvial Processes in River Engineering John Wiley 1988.
4. Simons D.B. and Senturk F., Sediment Transport Technology, Water Resources Publications, Fort Collins, Colorado 1977

PROGRAMME ELECTIVE-III/2WETPE09

## ENVIRONMENTAL IMPACT ASSESSMENT

**OBJECTIVES:**

- To understand the concept, historical context and wider importance of EIA as a planning tool.
- Students learn about EIA methodologies.
- Students will be able to assess the impact on soil and groundwater.
- To construct and assess the methodology for assessment of impacts on surface water environment.
- Students Illustrate and evaluate the stages of environmental audit.

**UNIT-I: Introduction:** Basic Concept of EIA, Initial Environmental Examination (IEE) and Environmental Impact Assessment, Initial Environmental examination (IEE), Important Steps in EIA, Systematic Approach for using EIA as a Planning Tool for Major Project Activities, concepts of water and carbon footprints.

**UNIT-II:EIA Methodologies:** Introduction, Criteria for the Selection of EIA Methodology, EIA Methods – Ad-hoc Methods, Matrix Methods, Network Methods, Overlay Methods, Cost / Benefit Analysis, environmental protection laws.

**UNIT-III: Assessment of Impact of Developmental Activities and Land use:** Methodology for the Assessment of Soil and Groundwater, Delineation of Study Area, Identification of Activities, Description of Existing Soil/Groundwater Resources Soil Characteristics, Procurement of Relevant Soil Quantity, Assessment of Impact Significance on landfills and human habitation.

**UNIT-IV: Environmental Impact Assessment on Water:** Introduction, Projects which Crate Impact Concerns for the Surface Water Environment, Systematic Methods for Evaluation of Impact of Various Developmental Activities on surface water Environment, Identification of Surface Water Quality or Quality Impacts, Description of Existing Surface Water Resources Conditions, Procurement of Relevant Surface Water Quality, Impact Prediction, Interpretation of Impact Significance on Water Resources Projects.

**UNIT-V: Environmental Audit:** Objectives of Environmental Audit, Advantages of Environmental Audit, Waste Audit, Energy Audit, Compliance Audit, Management Audit, Audit Protocol, Audit Procedure, Stages of Environmental Audit, Program Planning, On Site Activities, Evaluation of Audit Data and Preparation of Audit Report, EIA case studies.

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the basic concept of EIA, important steps in EIA and systematic approach for using EIA as a planning Tool for Major project activities.

CO2: Identify the EIA methodologies and criteria for selection of EIA methodology.

CO3: Recognize the impact of development activities and land use on soil and groundwater resources and assess the impact significance on landfills and human habitation.

CO4: Identify and interpret the projects which create impacts on surface water environment, surface water quality, Impact significance on water resources project.

CO5: Understand the concept of environment audit, its objective, different types of audit and experience on site activities and gain technical knowledge during the field visit to industries.

**TEXT BOOKS:**


- Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, Valli Manickam, B.S. Publication, Sultan Bazar, Hyderabad 2020.
- Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke, Prentice Hall Publishers, 1988.


**REFERENCE BOOKS:**


1. Environmental Science and Engineering, by Suresh, K. Dhaneja – S.K.,Katania &. Sons Publication, New Delhi.
2. Environmental Pollution and Control, by Dr H.S. Bhatia – Galgotia Publication (P) Ltd, Delhi, 2003.

PROGRAMME ELECTIVE-IV/2WETPE10

## SUSTAINABLE WATER RESOURCES DEVELOPMENT

**OBJECTIVES:**

- It is intended to create awareness among students about sustainability of water resources goals and policy approaches.
- Students understand national water policy, challenges, global issues and concerns as a part of sustainable water resources development.
- Students are exposed to local, regional and global perspective of sustainable water resources management.
- Students learn about various economic water issues and water conservation.
- The students are taught about water act and measures for sustainable water resources development.

**UNIT-I: Introduction:** Concept Of Sustainable Development, Sustainability Principles For Water Management, Goals For Guiding Sustainable Water Resource Management, Important Preconditioning In Water Policy Approaches, Framework For Planning A Sustainable Water Future.

**UNIT-II:Sustainable Water Resources Development:** Sustainability, Sustainability in Water Resources, National Water policy, National Water Mission, Challenges to sustainable development of water resources, framework for sustainable development of water resources, The global water crisis, Global initiatives, Water and ethics, Global water tele-connections and virtual water.

**UNIT–III: Sustainable Water Resources Management:** Sustainable Water Resources Management in A Local, Regional and Global Perspective, Water Resources-Their Use and Management, and Challenges to Achieve Sustainable Use and Management.Sustainable development goals – Net zero

**UNIT IV: Water Economics:** Economic view of water issues, economic characteristics of water good and services, Non-market monetary valuation methods, Water economic instruments, policy options for water conservation and sustainable use, Pricing, distinction between values and charges, Private sector involvement in water resources management.

**UNIT-V: Measures for sustainable development:** Water act, sustainable water resource management, government water conservation policies, general measures for sustainable development in water resources, sustainable water resources in India.

**COURSE OUTCOMES**

The student is expected to

**CO1:** To know about frame work for sustainable development of water Resources keeping global water crises in view.

**CO2:** To learn virtual water, national water policy, national water mission along with the challenges in the development of sustainable development of water resources.

**CO3:** To be thorough sustainable water resources management in local, regional and global perspective including the challenges to achieve sustainable water use and management.

**CO4:** To gain knowledge regarding water economics, options for water conservation and private sector involvement in water resources management.

**CO5:** To be well versed with water act, government policies on water conservation and the measures for sustainable water resources.

**TEXT BOOKS:**


- S.K.Gupta "Modern Hydrology and Sustainable Water Development" November 2010, Wiley-Blackwell.
- Cech, Thomas V., Principles of Water Resources: History, Development, Management and Policy. John Wiley and Sons Inc., New York. 2003.
- Mollinga .P. Etal "Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

PROGRAMME ELECTIVE-IV/2WETPE10

## CLIMATE CHANGE ADAPTATION AND MITIGATION

**OBJECTIVES:**

- To understand the concept, historical context and wider importance of Climate change and its impacts.
- To understand the framework of climate risk assessment.
- To develop solutions for climate change adaptation and mitigation for different sectors.
- To understand the Indian and international climate change policy and finances.

**UNIT-I: Introduction:** Weather and Climate, Variability, Basic Concept of Climate Change, Sources of Green House Gases (GHGs), natural and anthropogenic contribution towards climate change, different climatic models, GCM, RCM and projections, impact of climate change on different sectors, impact of CC globally, impact of CC in India, Climate change education and awareness.

**UNIT-II: Climate Risk Assessment (CRA):**Definitions, Climate hazards, Floods, droughts, heat waves, cyclones, storm surge, climate impacts, susceptibility, climate risk, vulnerability, social vulnerability, adaptive capacity, Gender aspects, Participatory rural appraisal (PRA), focused group discussions, CRA for different sectors like Urban, Agriculture, Forest, Industry, Tools for carrying out CRA and ranking methods.

**UNIT-III: Climate Change Adaptation:** Definitions, Adaptation and Disaster Risk Reduction, losses and opportunities, Soft and Hard measures, different types of adaptation, adaptation for different sectors community, urban, agriculture, forest, industry, cost-benefit analysis of adaptation measures, prioritization, water audits and water footprints estimation and associated measures. Concepts of smart cities, sustainable cities, integrated water management,

**UNIT-IV: Climate Change Mitigation:** Definitions, Technological options to reduce emissions, fossil fuel, successful case studies, energy efficiency, renewable energy, solar, wind, bio-gas, low carbon development, sustainable transportation, clean development mechanism, carbon sequestration, carbon footprints and emissions estimation, Cost of mitigation, cost-benefit analysis, Business models to promote energy efficiency ESCO, venture capital, prioritization of mitigation measures, Life Cycle Assessments and Extended Producer Responsibilities, Circular Economy, analysis of co-benefits of adaptation and mitigation, Food-water-energy nexus.

**UNIT-V: Climate Change Finance and Policy: S**ources of climate change finance, national and international funding agencies, UN, WB, ADB, Green Climate Fund, International treaties on climate change, UN framework for climate change, Montreal and Kyoto Protocol, United Nations Sustainable Development Goals, Indian Policies on Climate Change, Paris Agreement, India's Intended Nationally Determined Contributions (INDC), National Action Plan for Climate Change, State Action Plan for Climate Change

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the basic concept of climate change and its impacts on earth and India.

CO2: Evaluate the climate risk for different sectors.

CO3: Develop an adaptation plan for various sectors and prioritize the measures based on impact and cost-benefit analysis.

CO4: Propose mitigation measures; carry out carbon emission reduction and cost benefit analysis.

CO5: Understand the international and national policies on climate change along with sources of finance for implementing CCA and CCM measures.

**TEXT BOOKS:**

- Climate Change Modeling, Mitigation, and Adaptation. American Society of Civil Engineers. Zhang, T. C., Ojha, C. S. P., & Kao, C. M. (2013, March).
- Handbook of climate change mitigation and adaptation Chen, W. Y., Suzuki, T., & Lackner, M. (Eds.). (2016) New York: Springer.
- Climate Change by Joseph Romm, 2015.

**REFERENCE BOOKS:**

- IPCC fifth assessment report: Technical Summaries for Working Group I-III (freely available online athttp://www.ipcc.ch/report/ar5/)

PROGRAMME ELECTIVE-IV/2WETPE10

## ENVIRONMENTAL ENGINEERING-II

**OBJECTIVES:**

- Outline planning and the design of wastewater collection, conveyance and treatment systems for a community/town/city
- Provide knowledge of characterization of wastewater generated in a community
- Impart understanding of treatment of sewage and the need for its treatment.
- Summarize the appurtenance in sewerage systems and the irnecessity
- Teach planning, and design of septic tank and imhoff tank and the disposal of the effluent from these low cost treatment systems
- Effluent disposal method and realise the importance of regulations in the disposal of effluents in rivers

**UNIT – I: Introduction to Sanitation** – Systems of sanitation – relative merits & demerits – collection and conveyance of wastewater – sewerage – classification of sewerage systems- Estimation of sewage flow and storm water drainage – fluctuations – types of sewers - Hydraulics of sewers and storm drains– design of sewers.
**UNIT – II: Sewer appurtenances** – cleaning and ventilation of sewers. Pumping of wastewater: Pumping stations – location – components– types of pumps and their suitability with regard to wastewaters. House Plumbing: Systems of plumbing-sanitary fittings and other accessories– one pipe and two pipe systems – Design of drainage in Gate communities, Apartments and Hotels.
**UNIT – III: Sewage characteristics** – Sampling and analysis of wastewater - Physical, Chemical and Biological Examination-Measurement of BOD and COD – BOD equations. ThOD and Nirogen Oxygen Demand. Ultimate Disposal of sewage: Methods of disposal – disposal into water bodies-Oxygen Sag Curve-Disposal into sea, disposal on land, Crown corrosion, Sewage sickness. Effluent standards.
**UNIT – IV: Treatment of Sewage**: Primary treatment- Screens- Grit chambersGrease traps– floatation– Sedimentation – Design of preliminary and primary treatment units. Secondary treatment: Aerobic and anaerobic treatment processcomparison. Suspended growth process: Activated Sludge Process, principles, designs, and operational problems, modifications of Activated Sludge Processes, Oxidation ponds, Aerated Lagoons. Attached Growth Process: Trickling Filters – mechanism of impurities removal – classification – design, operation and maintenance problems. RBCs, Fluidized bed reactors.
**UNIT V: Miscellaneous Treatment Methods:** Nitrification and DenitrificationRemoval of Phosphates – UASB–Membrane reactors- Integrated fixed film reactors. Anaerobic Processes: Septic Tanks and Imhoff tanks-working Principles and Design– Reuse and disposal of septic tank effluent, FAB Reactors. Bio-solids (Sludge) management: Characteristics-SVI, handling and treatment of sludge-thickening – anaerobic digestion of sludge, Sludge Drying Beds. Centrifuge. Case studies.

**TEXT BOOKS:**


- Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill edition.
- Elements of Environmental Engineering, K. N. Duggal, S. Chand & Company Ltd. New Delhi,2012.


**REFERENCE BOOKS:**


- Industrial Water and Wastewater Management, K.V.S.G. Murali Krishna.
- Environmental Engineering, Howard S. Peavy, Donald R. Rowe, Teorge George Tchobanoglus – Mc-Graw-Hill Book Company, New Delhi,1985
- Wastewater Treatment for Pollution Control and Reuse, Soli. J Arceivala, Sham R Asolekar, Mc-GrawHill, New Delhi; 3rdEdition
- Environmental Engineering –II: Sewage disposal and Air Pollution Engineering, Garg, S. K., Khanna Publishers
- Sewage treatment and disposal, P. N. Modi & Seth.
- Environmental Engineering, Ruth F. Weiner and Robin Matthews – 4th Edition Elsevier,2003
- Environmental Engineering, D. Srinivasan, PHI Learning Private Limited, New Delhi, 2011

PROGRAMME ELECTIVE-IV/2WETPE10

## PYTHON SCRIPT PROGRAMMING

**OBJECTIVES:**

1. To introduce the fundamental concepts of scripting language.
2. To familiarize with the OOPS concepts
3. To comprehend Modules and regular expressions in scripting environment.
4. To acquire working knowledge of File and Database Connections , and
5. To have an exposure to UI programming.

UNIT 1: Fundamentals of Python: Introduction to Python; Installation of python; Code execution ways; Data types Control statements (if, if else); Iterators and generators (For , While, yield ), Operators; Functions in python.

UNIT 2: Introduction to OOPS: Features of OOPS; Classes and Objects; Types of class methods; Inheritance; Encapsulation, Abstraction; Polymorphism; Exception handling.

UNIT 3: Introduction to Modules and regular expressions: Introduction to regular expression; Working strings using RE; Working with files using RE; Introduction to modules; Creating own modules; In-built modules and GIS modules; Common usage models for Excel, Database.

UNIT 4: File and Database Connections: Reading and writing data from notepad and Excel; Installation of database (MySQL for python); Database Connections (MySQL); Working with queries (Update, delete, Insert, Retrieving).

UNIT 5: Introduction to UI programming: Introduction to TKINTER module; Root window; Containers; Canvas; Frames; UI Elements (Button, Message, Text, Menu etc…).

**COURSE OUTCOMES:**

The student will have exposure to

CO1: Fundamentals of PYTHON

CO2: Familiar with various elements of Python script programming, namely OOPS

CO3: Integration of Modules and regular expression in PYTHON.

CO4: Data base programming

CO5: With abovementioned background they will be able to develop small application

**TEXT BOOKS:**

1. Core python Programming by Dr Nageswrara rao.
2. Python Cookbook by Brian Jones
3. Dive into Python 3 Mark Piligrim

AUDIT COURSE-2/2A03

# CONSTITUTION OF INDIA

**OBJECTIVES:**

- To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indiannationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the IndianConstitution.

**UNIT-I:History of Making of the Indian Constitution:** History, Drafting Committee, (Composition & Working).

**UNIT-II: Philosophy of the IndianConstitution:** Preamble, Salient Features.

**UNIT-III: Contours of Constitutional Rights &Duties:**

- FundamentalRights
- Right toEquality
- Right toFreedom
- Right againstExploitation
- Right to Freedom ofReligion
- Cultural and EducationalRights
- Right to ConstitutionalRemedies
- Directive Principles of StatePolicy
- FundamentalDuties.

**UNIT-IV:Organs ofGovernance:**

- Parliament
- Composition
- Qualifications andDisqualifications
- Powers andFunctions
- Executive
- President
- Governor
- Council ofMinisters
- Judiciary, Appointment and Transfer of Judges,Qualifications
- Powers andFunctions

**UNIT-V: LocalAdministration:**

- District's Administration head: Role andImportance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CEO of MunicipalCorporation.
- Panchayati raj: Introduction, PRI:Zilla Panchayat.
- Elected officials and their roles, CEO Zilla Panchayat: Position androle.
- Block level: Organizational Hierarchy (Differentdepartments),
- Village level: Role of Elected and Appointedofficials,
- Importance of grass rootdemocracy

**UNIT-VI: Election Commission:**

- Election Commission: Role andFunctioning.
- Chief Election Commissioner and ElectionCommissioners.
- State Election Commission: Role andFunctioning.
- Institute and Bodies for the welfare of SC/ST/OBC andwomen.

**COURSE OUTCOMES:**

Students will be able to:

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4: Discuss the passage of the Hindu Code Bill of1956.

**SUGGESTED READING**


- The Constitution of India, 1950 (Bare Act), Government Publication, 2015.
- Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2016.
- M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

AUDIT COURSE-2/2A03

# PEDAGOGY STUDIES

**OBJECTIVES:**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**UNIT-I: Introductionand Methodology:**

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions**.**
- Overview of methodology and Searching.

**UNIT-II:Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developingcountries.

- Curriculum, Teacher education.

**UNIT-III:Evidence on the effectiveness of pedagogical practices**

- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT-IV:Professional development:** alignment with classroom practices and follow- up support

- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large classsizes

UNIT-V: **Research gaps and future directions**

- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

**COURSE OUTCOMES:**

Students will be able to understand:

CO1: What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?

CO2: What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?

CO3: How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**SUGGESTED READING:**


- Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
- Agrawal M (2004) curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3):361-379.
- Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London:DFID.
- Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3):272–282.
- Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston:Blackwell.
- Chavan M (2003) Read India: A mass scale, rapid, 'learning to read'campaign.
- www.pratham.org/images/resource%20working%20paper%202.pdfHYPERLINK "http://www.pratham.org/images/resource%20working%20paper%202.pdf".

AUDIT COURSE-2/2A03

## STRESS MANAGEMENT BY YOGA

**OBJECTIVES:**

- To achieve overall health of body and mind.
- To overcome stress.

**UNIT-I:** Definitionsof Eight parts of yog. (Ashtanga)

**UNIT-II:** Yam and Niyam.

Do`s and Don'ts in life.

- Ahinsa, satya, astheya, bramhacharya andaparigraha
- Shaucha, santosh, tapa, swadhyay,ishwarpranidhan.

**UNIT-III:** Asan andPranayam

- Various yog poses and their benefits for mind &body

ii) Regularization of breathing techniques and its effects-Types ofpranayam

**COURSE OUTCOMES:**

Students will be able to:

CO1: Develop healthy mind in a healthy body thus improving social healthalso

CO2: Improve efficiency

**SUGGESTED READING**


- 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal,Nagpur
- "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department),Kolkata

AUDIT COURSE-2/2A03

## PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

**OBJECTIVES:**

- To learn to achieve the highest goalhappily.
- To become a person with stable mind, pleasing personality anddetermination.
- To awaken wisdom instudents.

**UNIT-I:** Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22(wisdom)
- Verses- 29,31,32 (pride &heroism)
- Verses- 26,28,63,65(virtue)
- Verses- 52,53,59(dont's)
- Verses- 71,73,75,78(do's)

**UNIT-II:**Approach to day to day work andduties.

- Shrimad BhagwadGeeta: Chapter 2-Verses 41,47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23,35,
- Chapter 18-Verses 45, 46, 48.

**UNIT-III:**Statements of basicknowledge.

- Shrimad BhagwadGeeta: Chapter2-Verses 56, 62,68
- Chapter 12 -Verses 13, 14, 15, 16,17,18
- Personality of Role model. Shrimad BhagwadGeeta:
- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18,38,39
- Chapter18 – Verses37,38,63

**COURSE OUTCOMES:**

Students will be able to

CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal inlife

CO2: The person who has studied Geeta will lead the nation and mankind to peace andprosperity

CO3: Study of Neetishatakam will help in developing versatile personality ofstudents.

**SUGGESTED READING**


- "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department),Kolkata
- Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, NewDelhi.

LAB 3/2WETL11

## GIS AND IMAGE PROCESSING LABORATORY

**OBJECTIVES:**

1. To delineate the watershed area.
2. To prepare various thematic maps.
3. To carry out geometric correction of satellite data using ground control points (GCPs) and preparing mosaics of satellite images.
4. To generate Digital Elevation Models (DEM) and NDVI of AOI.
5. To prepare Land use/land cover maps using unsupervised and supervised classification algorithms.

### List of Practicals

- Geo Referencing of the Scanned Toposheet/maps using ground control points.
- To delineate the Boundary for the Watershed/ Catchment Area.
- To prepare the Base map for the given study Area.
- To prepare the Drainage map for the Delineated Catchment Area
- To prepare the Contour map for the Delineated Catchment Area
- To Generate the Slope map for the given study Area.
- To prepare the Land Use Land Cover map for the given study Area.
- To Import the raw Satellite data into Raster Image.
- To create a Subset for the Satellite Image
- To Mosaic the satellite Images
- Preparation of DEM map of the study area
- Preparation of drainage maps of area of interest.
- To Execute Unsupervised Classification for the Delineated Study Area
- To generate the Land Use/Land Cover for the area of interest using Supervised Classification
- To generate NDVI (Normalized Differential Vegetative Index) map.

**COURSE OUTCOMES**

The Student is expected to

CO1: Identify and generate different types of maps using GIS software.

CO2: Prepare the maps for the delineated catchment area using GIS.

CO3: Carry out geometric correction of satellite data using ground control points (GCPs), and preparing mosaics of satellite images.

CO4: Generate Digital Elevation Models (DEM) and NDVI from satellite image of AOI.

CO5: Prepare Land use/land cover maps using unsupervised and supervised classification algorithms.

LAB 4/2WETL12

## WATER RESOURCES MODELLING LABORATORY

**OBJECTIVES:**

1. To apply SWAT and CROPWAT softwares in watershed analysis.
2. To identify rainwater harvesting structures.
3. To prepare Priority watershed maps, flood maps showing inundated areas, Surface water body inventory maps and drought maps.
4. To apply EPANET for designing pipe network distribution.
5. To model the aquifer parameters.

### List of Practicals

- To introduce SWAT modeling software.
- Application of Geomatics for watershed analysis using SWAT.
- Application of Geomatics for rainfall-runoff modeling using freeware.
- Evapotranspiration modeling using CROPWAT.
- Preparation of groundwater table of area of interest using Geomatics
- Identification of harvesting structures in the given area.
- Preparation of prioritization of watershed maps.
- Preparation of flood maps and flood inundated areas.
- Preparation of drought maps and drought analysis.
- Preparation of surface water body inventory of the given study area.
- To design the pipe distribution by EPANET and GIS pipe.
- To model groundwater resources using MODFLOW.

**COURSE OUTCOMES:**

The Student is expected to

CO1: Apply the concept of geomatics for watershed analysis and rainfall-runoff modeling using SWAT.

CO2: Execute Evapotranspiration modeling using CROPWAT.

CO3: Identify harvesting structures in given area.

CO4: Priority watershed maps, flood maps including inundated areas, Surface water body maps, drought maps and their analysis.

CO5: Design the pipe distribution network and model the groundwater resources.

CORE/2WET13

## MINI PROJECT WITH SEMINAR

**The mini project will be based on the work done during the industrial training/internship of two months provided during semester break.**

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done

- Along with the report on identification of topic for the work and
- The methodology adopted involving scientific research, collection and analysis of data,
- Determining solutions highlighting individuals' contribution.

Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.

**COURSE OUTCOMES:**

CO1: Students will get an opportunity to work in actual industrial environment if they opt for internship.

CO2: In case of mini project, they will solve a live problem using software/analytical/computational tools.

CO3: Study different techniques used to analyze complex systems

CO4: Students will learn to write technical reports.

CO5: Students will develop skills to present and defend their work in front of technically qualified audience.

SEMESTER-III

PROGRAMME ELECTIVE –V/3WETPE14

## APPLICATION OF SOFT COMPUTING TECHNIQUES

## OBJECTIVES:

- To familiarize with soft computing concepts.
- To gain knowledge about basics of ANN and neural network modeling.
- To understand basics of the fuzzy logic concepts, fuzzy principles and relations.
- To apply knowledge of neuro fuzzy application and formulate neuro fuzzy modeling.

**UNIT-I:**

Introduction to Artificial Intelligence. Basics of MATLAB. Programming in MATLAB: Scripts and Functions, Graphics

**UNIT-II:**

**Fundamental concepts of Artificial Neural Networks:** Model of a neuron, activation functions, neural processing, Network architectures, learning methods.

**UNIT-III: Neural network Models:** Feed forward Neural Networks, Back propagation algorithm, Applications of Feed forward networks, Recurrent networks, Hopfield networks, Hebbian learning, Self organizing networks, unsupervised learning, competitive learning.

**UNIT-IV:**

**Fuzzy Set Theory:** Basic definitions and terminology and membership functions – Formulation and parameters, basic operations of fuzzy sets – complement, intersection vision, T-norm and T- conorm.
**Fuzzy Reasoning and Fuzzy Inference:** Fuzzy relations, Fuzzy rules, Fuzzy reasoning, Fuzzy Inference Systems, Fuzzy modeling, Applications of Fuzzy reasoning and modeling in Civil Engineering Problems.

**UNIT-V:**

**Neuro - Fuzzy Modelling:** Neuro-Fuzzy inference systems, Neuro-Fuzzy control.
**Applications of Neuro-Fuzzy computing:** Hydrologic Modelling time series Analysis and modeling, , Prediction of watershed runoff, Optimal reservoir operation.

### Text/Reference Books:


1. Jang, JSR, C.T. Sun and E. Mizutani (1997), "Neuro-Fuzzy and Soft Computing", Prentice Hall, NJ.
2. Haykin, S.(1994), "Neural Networks, A Comprehensive Foundation", McMillan College Publishing Company
3. Kosko, B. (1997),"Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd., New Delhi
4. Rao V and H. Rao, (1996), "C++" Neural Networks and Fuzzy Logic, BPB Publications, NewDelhi.
5. Pratap R (2010). Getting Started with MATLAB, OXFORD Publication.


## COURSE OUTCOMES:

Upon completion of this course students will be able to:

1. List the facts and outline the different process carried out in fuzzy logic and ANN.
2. Apply Soft computing techniques to solve character recognition, pattern classification, regression and similar problems.
3. Explain the concepts of soft computing and familiar with various computing software.
4. Evaluate various techniques of soft computing to defend the best working solutions.

PROGRAMME ELECTIVE –V/3WETPE14

## ADVANCED NUMERICAL METHODS

**OBJECTIVES:**

1. To apply Computer oriented methods for solving numerical problems in science and engineering
2. To solve Numerically systems of simultaneous linear equations, nonlinear algebraic equations (root solving), differentiation and integration, ordinary differential equations, interpolation.

**UNIT-I: Introduction:** Introduction to numerical methods and analysis and computer programming; Error Analysis: Approximations; Round off and Truncation errors; Error Analysis. Roots of Equations (single variable): Method of Bisection, Regular Falsi, Secant Method, Fixed point Method, Newton Raphson method, Multiple roots. Analysis and order of convergence. Polynomials: Mueller's method, Bairstow's method.

**UNIT-II: Solution of Linear System of Equations:** Dense, Sparse and Banded systems, Direct Methods -Gauss Elimination, Gauss-Jordan, LU decomposition, Thomas Algorithm. Condition number of matrix, effect of round-off errors. Iterative improvement of solution by direct methods. Iterative methods: Jacobi and Gauss Seidel iteration, rate of convergence of iterative methods. Successive over Relaxation. Solution of Nonlinear System of Equations: Iterative methods, Fixed Point iteration, Newton-Raphson method.

**UNIT-III: Approximation Theory:** Approximation of Continuous functions -basis functions, norms and semi-norms, inner product, formulation of least square problem, derivation of normal equations, orthogonal basis functions. Tchebycheff and Legendre polynomials. Interpolating polynomials: Newton's divided difference polynomial, Lagrange polynomials. Interpolation using spline functions: linear, quadratic and cubic splines. Polynomial regression of discrete data. Transformation of nonlinear problems to linear approximation problems.

**UNIT-IV:Eigenvalues and Eigenvectors:** Power method, inverse power method. Fadeev-Leverrier method for formulation of the Characteristic polynomials, QR decomposition.

Numerical Differentiation: Introduction to finite difference approximations, truncation error analysis. Finite difference approximations on irregular grid. Richardson's extrapolation. Numerical Integration: Rectangular rule, Trapezoidal Rule and Simpson's rule. Local and global error analysis.

**UNIT-V: Romberg Integartion.** Gauss Quardrature, Improper Integrals. ODE, Initial Value Problems: Euler's method, improvement of Euler's method, Runge -Kutta Methods, Multi Steps Methods. Predictor Corrector Methods. ODE, Boundary Value Problems: Decomposition into Linear System of ODEs, Shooting Method, Direct Method. Partial Differential Equations: Elliptic, Parabolic and Hyperbolic Equations, Explicit and Implicit Methods, Crank Nicholson Method.

**REFERENCES:**


- Jain M.K, SRK Iyenge and RK Jain, "Numerical Methods for Scientific &Engg. Computation".
- Mathews J. H "Numerical Methods for Mathematics, Science and Engineering".
- Gerald C.F and PO Wheatley "Applied Numerical Analysis".
- Gupta S.C and V. K. Kapoor "Fundamentals of Applied Statistic", Sultan Chand &Sons.
- Johnson R.A "Probability and Statistics for Engineers."
- Rajeshwaran S, "Numerical Methods in Science & Engineering (A Practical Approach)", Willey Publication.


**COURSE OUTCOMES:**

After the completion of the course the students will be able to

**1:** Familiarize with finite precision computation, numerical solutions of nonlinear equationsin a single variable.

**2:** Familiarize with numerical interpolation and approximation of functions, numerical integration and differentiation.

**3:** Familiarize with numerical solution of ordinary differential equations.

**4:** Familiarize with calculation and interpretation of errors in numerical methods

PROGRAMME ELECTIVE –V/3WETPE14

## SOLID AND HAZARDOUS WASTE MANAGEMENT

**OBJECTIVES:**

- The students are expected to learn about solid waste, characteristics and its disposal methods
- It creates awareness regarding hazardous waste, characterization and control.
- The students learn about management, minimization and audit of hazardous waste
- The students understand bio and electronic waste, its safe disposal and 3R concept.
- The students acquire knowledge about methods of remediation of waste land followed by reclamation

**UNIT-I: Introduction:** Definition of Solid Wastes, Domestic Solid Wastes, Types of Domestic Solid Wastes, Collection, Transportation, Characteristics of Solid Waste, Segregation, Principles of waste disposal, site selection, Types of Disposal Methods, Sanitary Land Fill, Incineration, Composting, Vermi Compost, Recovery of Energy from Solid Wastes.

**UNIT-II: Hazardous Wastes:** Introduction, Physical and Biological Routes of Transport of Hazardous Substances, Environmental Laws, Indian Scenario, Special Hazardous Wastes, Hazardous Waste Sources and Characterization Categories and Control, Sampling and Characterization, Analysis of Hazardous Wastes.

**UNIT-III: Hazardous Waste Management and waste minimization Technologies:** Waste Recovery Processes, Solidification, Stabilization and Encapsulation, Biological Processes, Thermal Processes. Storage and Transportation Including Optimization, Disposal Facilities, TSDF Cradle to Grave Concept, Land Disposal of Wastes, Land Fills, incineration, Underground Disposal, Sea Disposal, Pollution Prevention and Recycling, Environmental Facility Assessment and Audit Waste Minimization, Hazardous Waste Remediation Technologies.Bio gas generation – Field visit to M/s.Ramky, Jawahar Nagar, impact of Methane gas production.

**UNIT-IV: Biomedical & Electronic Waste:** Hospital/Biomedical Waste Management Including Collection, Transportation, Treatment and Safe Disposal. Zero Waste Technology, Re-Use and Recycling of Wastes, Recovery of By-Products and Energy Audit

**UNIT-V: Waste Land Remediation and Reclamation:** Definition of Waste Land, Characteristics of Waste Land, Physical, Chemical and Biological Pollution of Soils, Dumping, land Fills, Leachate Problems, Remediation Methods-Physical, Chemical and Biological Methods.

**COURSE OUTCOMES**

The student is expected to

CO1: To know about solid and hazardous waste transportation, environmental laws and analysis of hazardous waste.

CO2: Learn waste recovery processes, cradle to grave concept of handling hazardous waste.

CO3: Understand disposal of hazardous waste both on surface and underground and waste minimization and hazardous waste remediation technologies.

CO4: Be familiar with collection transportation treatment and safe disposal of both biological and electronic waste and be conversant with reuse and recycling of wastes, recovery of by products and energy audit.

CO5: Gain knowledge about waste land characteristics and its remediation, different kinds of pollution of soils, remediation methods.

**TEXT BOOKS:**


- Solid and Hazardous Waste Management by M.N.Rao & Razia Sultana, B.S.Publishers, 2011.
- Hazardous Waste Management by Charles A.Wentz, McGraw Hill Publishers, 1995.
- Standard Hand Book of Hazardous Waste Treatment and Disposal by H.M. Free man, McGraw Hill, 1997.


**REFERENCE BOOKS:**


1. Integrated Solid Waste Management by George Tchobanolous, Hilary Theisen & Samuel A.Vigil, McGraw-Hill Companies,Incorporated, 1993.
2. CPCB Manual on Solid Waste Management, 2003.

PROGRAMME ELECTIVE –V/3WETPE14

## HYDRO POWER ENGINEERING

**OBJECTIVES:**

- It deals with understanding of hydropower schemes and types
- Intended to create awareness regarding intake structures and penstocks
- The students learn about water hammer and its analysis
- The students understand surge tanks, their working and computations
- The students learn about different types of power houses along with their suitability

**UNIT-I:** Classification of Hydropower Schemes, Load Studies and factors, Flow duration curve, Firm and secondary power pondage and storage.

**UNIT-II:** Low and high head intakes, fore bay trash rack, gates and tier operation, air vent, Design of Penstock, Pen stock anchorages.

**UNIT-III: Water hammer analysis**: Basis equations, solution for linearized equations, arithmetic method and graphical method.

**UNIT-IV: Surge tanks:** Different types, their working, Computation of Surges in simple surge tank, Surge stability.

**UNIT-V: Power Houses:** General arrangement of overgrown lower houses component parts and their functions, Criteria for fixing power house dimensions, Selection of type and capacity of turbine. Underground power houses: Types of layout their suitability and merits.

**COURSE OUTCOMES**

The student is expected to

CO1: To know about hydropower systems, types, different load studies, pondage and storage.

CO2: Understand different intake structures, layout of a hydropower plant, penstock, design and anchorages.

CO3: Learn about water hammer, analysis, solution of linearized equations.

CO4: Be familiar with surge tanks, types, working, computations and stability analysis.

CO5: Be well acquainted with power houses, arrangement, selection of type, criteria for fixing dimensions, layout of underground power houses, stability and merits.

**TEXT BOOKS:**

- Hydropower structure by R.S.varshney, 2014.
- Water Power Engineering by M.M. Dandekar, K. N.Sharma, Vikas Publishing House2013.
- Fluid Transients by V.L.Streeter, Prentice Hall, 1993.

PROGRAMME ELECTIVE –V/3WETPE14

## MICRO IRRIGATION TECHNOLOGIES

**OBJECTIVES:**

- The students understand the concept of micro irrigation, survey of fields and data to be collected in the design of irrigation system.
- The students gain knowledge about drip and sprinkler irrigation systems including their design and their suitability to different crops.
- The students gain knowledge about land scaping for irrigation, poly houses, farm houses.
- The students became familiar with Automation and Fertigation.
- The students learn installation, operation and maintenance of piping system.

**UNIT I: Field Data Collection:** Introduction to Survey of fields, Introduction to survey for Pipelines, Soil and Water Sample collection procedures, Data to be collected from field and their importance in design of an irrigation system.

**UNIT II: Drip and Sprinkler Irrigation Systems:** Preparation of Drawings, Estimate and Bill of Quantities, Use of item codes. Worked out Examples for Tree Crops, Row Crops & Intercrops, Introduction of sprinkler Irrigation systems, types of sprinklers, Mini and Micro sprinklers, Preparation of designs, drawings, Estimate and Bill of Quantities, Use of item codes.

**UNIT III: Landscape Irrigation System:** Site specific installation requirement, Understanding the landscape architects plan, Irrigation system for road dividers, poly houses, farm houses, sports ground – GUN sprinkler, Design of Sprinkler Irrigation Systems for Turf and Golf Courses, Use of treated wastewater.

**UNIT IV: Automation and Fertigation:** Concept, Necessity, Advantages, Types, Components, Design, preparation of Bill of quantities, Preparation of irrigation and fertigation schedule, Fertigation with alkaline water, Fertigation with acid water, Special instruction on use of equipment.

**UNIT -V: Installation, Operation and Maintenance of Irrigation Systems:** Planning for trenching work, transportation and storage of PVC/HDPE pipes, Lowering, Laying and Jointing of pipes and installation work, Design, Operation & maintenance of lift irrigation piping. Operation and Maintenance of Micro Irrigation Systems: Daily, weekly and monthly maintenance, Chemical Treatments, their importance, procedures, calculations of chemical doses.

**COURSE OUTCOMES:**

The student is expected to

CO1: The design of an irrigation system.
CO2: Know about design of drip and sprinkler irrigation systems.
CO3: Understand the concepts of land scaping.
CO4: Gain knowledge on automation and fertigation.
CO5: Familiarize with operation and maintenance of irrigation systems.

**TEXT BOOKS:**

- Micro Irrigation Scheduling and Practices (Innovations and Challenges in Micro Irrigation) by Megh R. Goyal, Balram Panigrahi, Sudhindra N. Panda, Apple Academic Press, 2017
- Land and Water Management Engineering by V.V.N. Murthy, Kalyani Publishers, 2008.
- Irrigation –Theory and Practice" by Withers and Vipond, S, Cornell University Press, 1980.

**REFERENCE BOOKS:**

- Irrigation: Theory and Practice by Michael. A.M 2nd Edition, Vikas Publishing House,2009.
- Irrigation Principles and Practice by Hansen, V.E., Israelson O.S. and Stringham G.C. John Wiley & Sons, N York 1963.

PROGRAMME ELECTIVE –V/3WETPE14

## DESIGN OF HYDRAULIC STRUCTURES

**Course Objectives:**

1. To understand the basics of hydro power, classification of hydro plants.
2. To know the basics of Hydraulic structures along with the design of different components associated with it.
3. To analyze various hydraulic structures like concrete dam and spillway.
4. To get knowledge of various types of dam and understand different elements of dam.

**UNIT-I: Introduction:** Sources of Energy, Status of hydro power in the World. Transmission Voltages and Hydro-power, estimation of water power potential, General load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load.

**UNIT-II: Classification of Hydel Plants:** Run off river plants, general arrangement of runoff river plants, valley dam plants, diversion canal plants, high head diversion plants storage and pondage, Pumped storage plants: Types of Pumped storage plants, relative merits of two unit and three unit arrangement. Three-unit arrangement, reversible pumps turbines, problems of operation, power house, efficiency of P-S plants.

**UNIT-III: Water Conveyance:** Classification of penstocks, design criteria for penstocks, economical diameter of penstock, anchor blocks, conduit valves, types of valves, bends and manifolds, illustrative, water hammer, resonance in penstocks, channel surges, surge tanks. **Intakes:** Types of intakes, losses of intakes, air entrainment at intakes, inlet aeration, canals fore bay, tunnels.

**UNIT-IV: Tidal power**: Basic principle, location of tidal power plant, difficulties in tidal power generation, components of tidal power plants, modes of generation, single basin arrangement, double basin system.

**Concrete Dams:** Investigation and Planning. Forces on Concrete dams, Types of loads, Stability analysis. Safety criteria, Gravity analysis, Internal stress calculation and Galleries. Joints and keys and cooling arrangement. Water stops at joint, closing gaps. Buttress and Arch Dam. Mass concrete for dams: Properties and quality control. Pressure grouting.

**UNIT-V: Spillway:** Types, Design principles of Ogee spillway, side channel spillway, Chute spillway, Siphon Spillway, shaft Spillway, Gates & Valves. Energy dissipators and stilling basin design. Outlet works.

**Earth and rock fill Dams:** subsurface explorations methods, cutoff trenches, sheet piling cutoffs, upstream blankets, horizontal drainage blankets and filters, toe drains and drainage trenches, pressure relief well. Seepage through embankments, Stability analysis of slopes of homogeneous and zoned embankment type under different reservoir conditions, Upstream and downstream slope protection measures.

**COURSE OUTCOMES:**

Upon completion of this course students will be able to:

1. Enhance knowledge on various concepts of hydro power generation and types of Hydel plants.
2. Select type of hydraulic structure and estimate tidal power, capacity and water load lines throughout various hydraulic structures.
3. Perform structural design and analyze the various aspects of different hydraulic structures.
4. Be able to select the type of dam, design and to construct.

PROGRAMME ELECTIVE –V/3WETPE14

## WEB DEVELOPMENT

OBJECTIVES:

1. To provide an exposure to concepts of HTML5
2. To provide hands on experience on working with HTML5 concepts
3. To provide an exposure to applying styles with CSS3
4. To study concepts of DotNet basics.
5. To provide a glimpse of working with windows services

**UNIT-I:** HTML5: HTML 5, Overview of HTML 5, HTML5 Syntax, Forms, Form Elements, New attributes for <form>, New attributes for <input>,Video and Audio, Types of Elements, HTML5 NEW ELEMENTS, Migration from HTML4 to HTML5, HTML5 DEPRECATED TAGS, HTML5 DEPRECATED ATTRIBUTES.

**UNIT-II:** Advanced concepts of HTML5: App Cache or Offline Applications, Web Storage, Web Workers, Server Sent Events - One Way Messaging, MathML, Geolocation, Drag and Drop API, File API, WEB SQL, Canvas Overview, SVG.

**UNIT-III:** CSS3: CSS 2.0 vs CSS 3.0,Introduction to css3,whats new in css3.0,border, background, Gradients, Linear Gradients, Radial Gradients, text effects, FONT Face, Google fonts, 2D Transforms, 3D Transforms, Box Resize, Box Sizing, Outline, Animations, Selectors, Multiple Columns, Converting Layout to HTML 5 & CSS 3.

**UNIT-IV:** WORKING With DOTNET: Introduction to Microsoft .NET framework: arrays, operators, flow control statements, functions and properties, C#.NET Language Basics-Working with Data Types -Type Conversion, Boxing & Unboxing, Conditional Statements (if, switch condition), operators, Looping Arrays, Enumerations.

**UNIT-V:** Creating Web Services: Windows forms and Event Controls., Understanding the services, Windows service Architecture, Windows Services- Service base class, Service Process installer, Service Installer, Creating a Windows Service, Installing and uninstalling windows services, Google Earth, KML Virtual Earth & Bhuvan.

### COURSE OUTCOMES:

The students will have exposure to

CO1: Fundamentals of HTML5.
CO2: Various types of tags in HTML5.
CO3: Familiarization with CSS3.
CO4: Concepts and working knowledge in DotNet.
CO5: Concepts and creation of web services.

### TEXT BOOKS:

1. The Complete Reference: HTML and CSS, 2nd & 5th Editions by Thomas A. Powel, McGraw Hill.
2. Ajax: The Complete Reference – Thomas A. Powel, McGraw Hill, 2008.
3. Web Technologies by Puntem bekhar Edition-2

### REFERENCE BOOKS:

1. Professional AJAX – Nicholas C Zakas et al, Wrox publications, 2006.
2. An Introduction to Web design and programming, Wang, Thomson.
3. Visual C# .NET Programming

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## BUSINESS ANALYTICS

**OBJECTIVES:**

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision-making.
- To become familiar with processes needed to develop, report, and analyze business data.
- Use decision-making tools/Operations research techniques.
- Mange business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

**UNIT I: Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

**Statistical Tools:** Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

**UNIT-II: Trendiness and Regression Analysis:**Modeling Relationships and Trends in Data, simple Linear Regression.

Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**UNIT-III:** Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

**UNIT-IV: Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

**Monte Carlo Simulation and Risk Analysis:** Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**UNIT-V: Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

**UNIT-VI: Recent Trends in:** Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

**COURSE OUTCOMES:**

Students will be able to

CO1: Demonstrate knowledge of data analytics.

CO2: Think critically in making decisions based on data and deep analytics.

CO3: Use technical skills in predicative and prescriptive modeling to support business decision-making.

CO4: Translate data into clear, actionable insights.

**REFERENCE BOOKS:**


- Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FTPress.
- Business Analytics by James Evans, persons Education.

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## INDUSTRIAL SAFETY

**UNIT-I:Industrial safety:** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

**UNIT-II: Fundamentals of maintenance engineering:** Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types ofmaintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT-III: Wear and Corrosion and Their Prevention:** Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

**UNIT-IV: Fault Tracing:** Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

**UNIT-V: Periodic and preventive maintenance:** Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

**REFERENCE BOOKS:**


- Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services, 1987.
- Maintenance Engineering, H. P. Garg, S. Chand andCompany1986.
- Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
- Foundation Engineering Handbook, Winterkorn, Hans, Chapman &Hall London, 1975.

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## OPERATIONS RESEARCH

**UNIT I**: Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

**UNIT II:** Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

**UNIT III**: Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

**UNIT IV:** Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

**UNIT V:** Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

**COURSE OUTCOMES:**

The student should be able to

CO1: Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.

CO2: Students should able to apply the concept of non-linear programming

CO3: Students should able to carry out sensitivity analysis

CO4: Student should able to model the real world problem and simulate it.

**REFERENCES BOOKS**:


- H.A. Taha, Operations Research, An Introduction, PHI,2008
- H.M. Wagner, Principles of Operations Research, PHI, Delhi,1982.
- J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi,2008
- Hitler Libermann Operations Research: McGraw Hill Pub.2009
- Pannerselvam, Operations Research: Prentice Hall of India2010
- Harvey M Wagner, Principles of Operations Research: Prentice Hall of India2010

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## COST MANAGEMENT OF ENGINEERING PROJECTS

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**REFERENCE BOOKS:**


- Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2008.
- Charles T. Horngren and George Foster, Advanced Management Accounting
- Robert S Kaplan, S. Mark young, Anthony A. Atkinson, Management &Cost Accounting, person education(US) 1994.
- Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. PHI Learning.
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co.Ltd., 2007.

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## COMPOSITE MATERIALS

**UNIT–I**: **Introduction:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT – II**: **Reinforcements:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT – III: Manufacturing of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT–IV: Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT – V: Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**TEXT BOOKS:**


- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition,2007.


**REFERENCE BOOKS:**


- Hand Book of CompositeMaterials-ed-Lubin, 1997.
- Composite Materials – K.K.Chawla, Springer international ediotion 2006.
- Composite Materials Science and Applications – Deborah D.L.Chung, Springer international ediotion 2010.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi, CRC Press 2002.

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## WASTE TO ENERGY

**UNIT-I: Introduction to Energy from Waste:** Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

**UNIT-II: Biomass Pyrolysis:** Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**UNIT-III: Biomass Gasification:** Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT-IV: Biomass Combustion:** Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT-V: Biogas:** Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**REFERENCES BOOKS:**


- Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
- Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
- Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
- Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

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## ENVIRONMENTAL STATISTICS

**OBJECTIVES:**

- To understand the concept, historical context and wider importance of Climate change and its impacts.
- To understand the framework of climate risk assessment
- To develop solutions for climate change adaptation and mitigation for different sectors
- To understand the Indian and international climate change policy and finances

**UNIT-I: Introduction to Statistics:** introduction to data, Types of data, sources of paid and free data, role of environmental statistics, Environmental Sampling, types of sampling, population, descriptive and inferential statistics, mean, standard deviation, standard error, median, mode, quartiles, kurtosis, variance and their significance, Exploratory data analysis and data visualization, hands-on in MS Excel.

**UNIT-II: Introduction to R:** What is R? R command and Scripts, R packages, R Working directory, R functions, getting data into R, Data cleaning, sub-setting and combining data, data transformation in R, carry out all basic analysis in R in both descriptive and inferential statistics

**UNIT-III: Probability and Statistic:** Experiments, Counting rules, events and probability, conditional probability and Bayes theorem, Discrete Probability distribution, Binomial and Poison Probability, Continuous probability distribution, Normal Probability distribution, interval estimation, Hypothesis test, Type I and Type II errors, inference of population mean known and unknown, use of environmental data, hands-on in Excel and R.

**UNIT-IV: Analysis of Variance, Correlation and Regression**: ANOVA, ANCOVA, simple regression model, Non-linear regression, coefficient of determination, t-test, F-Test, point and interval estimation, residual analysis, multiple regression, logistic regression, forecasting methods, Time series, Temporal data, autoregressive modeling, use of environmental data, hands-on excel and R.

**UNIT-V: Spatial Statistics:** Raster and Vector data reading and analysis in R, spatial point pattern analysis, local and global statistics, complete spatial randomness (chi-square, distance methods, Ripley's K-function), spatial measurements (autocorrelation, Morans I, Geary's c, semi variogram), Spatial correlation, spatial regressions, spatial prediction (simple, ordinary, universal kriging) hands on in R using environmental data,

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the data, sampling procedures, descriptive and inferential statistics in environmental data

CO2: Use R and MS Excel for basic statistical analysis for environmental data

CO3: differentiate discrete and continuous probabilities and its application in environmental science, carry out various test and hypothesis

CO4: use correlation, regression and analysis of various in R and Excel for interpreting environental data and use it for decision making

CO5: Understand the concept of spatial statistics and use it for environmental data for decision making

**TEXT BOOKS:**


- Piegorsch, W. W., & Bailer, A. J. (2005). Analyzing environmental data. John Wiley & Sons.
- Qian, S. S. (2016). *Environmental and ecological statistics with R*. Chapman and Hall/CRC.


**REFERENCE BOOKS:**


- Probability and statistics applications for environmental science by Shaefer, S. J., & Theodore, L. (2007). CRC Press.
- Statistical geoinformatics for human environment interface by Myers, W. L., & Patil, G. P. (2012). . Chapman and Hall/CRC.
- Statistics for environmental engineers by Brown, P. M. B. L. C., &Hambley, D. F. (2002).

## DISSERTATION-I

## DISSERTATION WORK REVIEW-I

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.

Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech.

The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.

The preliminary results (if available) of the problem may also be discussed in the report.

The work has to be presented in front of the examiners panel set by Head DRC.

The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

**COURSE OUTCOMES:**

**CO1:** Studentswill be exposed to self-learning various topics.
**CO2:** Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
**CO3:** Students will learn to write technical reports.
**CO4:** Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.

## DISSERTATION WORK REVIEW-II/3WET16

It is a continuation of Project work started in semester III.

He has to submit the report in prescribed format and also present a seminar.

The dissertation should be presented in standard format as provided by the department.

The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.

The report must bring out the conclusions of the work and future scope for the study.

The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator.

The candidate has to be in regular contact with his guide.

## COURSE OUTCOMES:

CO1: Students will be able to use different experimental techniques.
CO2: Students will be able to use different software/ computational/analytical tools.
CO3: Students will be able to design and develop an experimental set up/ equipment/test rig.
CO4: Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
CO5: Students will be able to either work in a research environment or in an industrial environment.
CO6: Students will be conversant with technical report writing.
CO7: Students will be able to present and convince their topic of study to the engineering community.

Eligibility Criteria:

| | |
|---|---|
| M.Tech (Water and Environmental Technology) | B.E./B.Tech/AMIE in Civil Engineering/ Agricultural Engineering/ Environmental Engineering and equivalent. |