

ACADEMIC REGULATIONS (R25)

COURSE STRUCTURE

AND

DETAILED SYLLABUS

For

M.Tech Two Year Programme

(Water Resource Engineering)

(Applicable for the batches admitted from the A.Y. 2025-26)



DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533003, ANDHRA PRADESH, INDIA



DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
ACCREDITED BY NAAC A⁺

Programme Structure
R25 M.Tech (Water Resource Engineering) Course Structure

M.Tech I Semester

S.No	COURSE NO	Course Name	Category	L	T	P	C
1	MWREI-1	Applied Hydrology	Program Core-1	3	1	0	4
2	MWREI-2	Remote Sensing And GIS	Program Core-2	3	1	0	4
3	MWREI-3	Design of Hydraulic Structure	Program Core-3	3	1	0	4
4	MWREI-4	a) Advanced Fluid Mechanics b) Advanced Numerical Methods and Applied Statistics c) Land And Water Management d) Environmental Impact Assessment and Management	Program Elective 1	3	0	0	3
5	MWREI-5	a) Integrated Watershed Management b) Water Resources Systems Planning and Management c) Data Analytics in Water Resources d) Industrial wastewater treatment	Program Elective 2	3	0	0	3
6	MWREPI-1	Geographic Information Systems (GIS) Applications Lab	Laboratory-1	0	1	2	2
7	MWREPI-2	Advanced Fluid Mechanics Lab	Laboratory-2	0	1	2	2
8	MWREA-1	Seminar -I		0	0	2	1
Total Credits/Marks				23			

1	Dr. K. Padma Kumari	<i>Padma Kumari</i>	7	Er.Sreenivas kolapalli	
2	Dr. V. Sreenivasulu	<i>V. Sreenivasulu</i>	8	Dr.Sai Nadurupati	
3	Dr. Vijay Kumar S.V.	<i>Vijay Kumar S.V.</i>			
4	Dr.K.B.V.N Phanindra				
5	Dr. Venkat Reddy				
6	Dr. R. Kannan				



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Programme Structure
R25 M.Tech (Water Resource Engineering) Course Structure
M.Tech II – Semester

S.No	COURSE NO	Course Name	Category	L	T	P	C
1	MWREII-1	Urban Hydrology	Program Core-4	3	1	0	4
2	MWREII-2	Groundwater Hydrology	Program Core-5	3	1	0	4
3	MWREII-3	Irrigation Water Management	Program Core-6	3	1	0	4
4	MWREII-4	a) Applications Of Remote Sensing & GIS in Water Resources & Environmental Engineering b) Design Of Water Supply and Sewerage Systems c) Coastal And Ocean Engineering d) Free Surface Flow	Program Elective- 3	3	0	0	3
5	MWREII-5	a) Fluvial Hydraulics b) Hydropower Systems c) Environmental Hydrology and Hydraulics d) Water Supply Systems	Program Elective-4	3	0	0	3
6	MWREMC	Hydrologic And Hydraulic Modelling Lab	Laboratory -3	0	1	2	2
7	MWREII-1	Water Resources Systems Design Laboratory	Laboratory -4	0	1	2	2
8	MWREA-2	Seminar -II		0	0	2	1
Total Credits / Marks				23			

1	Dr. K. Padma Kumari	<i>[Signature]</i>	7	Er.Sreenivas kolapalli	
2	Dr. V. Sreenivasulu	<i>[Signature]</i>	8	Dr.Sai Nadurupati	
3	Dr. Vijay Kumar, S.V.	<i>[Signature]</i>			
4	Dr.K.B.V.N Phanindra				
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Programme Structure
R25 M.Tech (Water Resource Engineering) Course Structure

M.Tech III – Semester

S.No.	COURSE NO	Course Name	Category	L	T	P	C
1	MWREIII-1	Research methodology and IPR Swayam 12 Week MOOC Course	RM-IPR	3	0	0	3
2		Summer Internship/ Industrial training (8-10 weeks)		--	--	--	3
3		Comprehensive Viva		--	--	--	2
3		Dissertation Part-A		--	--	20	10
		Total Credits / Marks					18

* Student Attended Summer/ Year Break and Assessment will be done in 3rd Sem

**Comprehensive viva can be conducted courses completing up to Second Semester

*** Dissertation –Part A, Internal Assessment

M.Tech IV - Semester

Sr No.	COURSE NO	Course Name	Category	L	T	P	C
1	Dissertation	Project / Dissertation Part-B	core	0	0	32	16
Total Credits / Marks							16

External Assessment

1	Dr. K. Padma Kumari	<i>Padma Kumari</i>	7	Er.Sreenivas kolapalli	
2	Dr. V. Sreenivasulu	<i>Sreenivasulu</i>	8	Dr.Sai Nadurupati	
3	Dr. Vijay Kumar, S.V.	<i>Vijay Kumar</i>			
4	Dr.K.B.V.N Phanindra				
5	Dr. Venkat Reddy				
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UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

(Established by Andhra Pradesh Act No.30 of 2008)

Kakinada – 533 003, Andhra Pradesh (India)

ACADEMIC REGULATIONS R25 FOR M. Tech (REGULAR) PG DEGREE COURSE

Applicable for the students admitted to M. Tech (Regular) Course from the Academic Year 2025-26 and onwards. The M. Tech Degree of Jawaharlal Nehru Technological University Kakinada shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University/affiliating bodies from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the State Govt./University or on the basis of any other order of merit as approved by the State Govt./University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M. Tech DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech Degree, if he pursues a course of study in not less than two and not more than four academic years. Under any circumstances, permission shall not be given to complete the course work beyond four years. University is at discretion to accord permission to register for the backlog subjects beyond maximum duration.

2.2 **The student shall register for all 80 credits and secure all the 80 credits.**

2.3 The minimum instruction days in each semester are 90.

3.0 PROGRAMMES OF STUDY

The following specializations are offered at present for the M. Tech Programme of study.

S.No.	Department	Programme
1	Civil Engineering	1. M.Tech- Structural Engineering 2. M. Tech- Soil Mechanics and Foundation Engineering 3. M.Tech-Water Resource Engineering
2	Electrical and Electronics Engineering	1. M.Tech- High Voltage Engineering 2. M.Tech- Advanced Electrical Power System 3. M.Tech- Power Electronics and Drives
3	Mechanical Engineering	1. M.Tech- CAD/CAM 2. M.Tech- Machine Design

		3. M.Tech- Mechanical Engineering (Thermal Engineering)
4	Electronics and Communication Engineering	1. M.Tech- Computer and Communication 2. M.Tech- VLSI and Embedded Systems 3. M.Tech- Communication Engineering and Signal Processing
5	Computer Science and Engineering	1. M.Tech- Computer Science and Engineering 2. M.Tech- Computer Science and Engineering (Artificial Intelligence and Machine Learning) 3. M.Tech- Cyber Security
6	Food Engineering	1. M.Tech- Food Processing and Technology

4.0 ATTENDANCE

- 4.1 Attendance is calculated separately for each course. Attendance in all classes (Lectures/Laboratories) is compulsory. The minimum required attendance in each course is 75%. A student shall not be permitted to appear for the Semester End Examinations (SEE), if his/her attendance is less than 75%.
- 4.2 Condoning of shortage of attendance (between 65% and 75%) up to a maximum of 10% (*considering the days of attendance in sports, games, NSS activities and medical exigencies*) in each course (Theory/Lab/Seminar) is condoned on production of valid Certificates/documents in the stipulated time mentioned here with:
- 4.2.1 Students who are admitted as in patients for treatment are only eligible to claim condonation of attendance. Such students under medical exigencies need to Produce (a) Doctor Medical Prescription, (ii) Medical bills duly signed by Doctor/Hospital authorities, (c) Diagnosis reports, if any, (d) Discharge summary issued at the time of discharge and any other supporting documents within one/two week(s) from the date of discharge to the respective institution.
- 4.2.2 Students participation in Sports/Games and NSS activities shall also be permitted for condonation of attendance. In such cases, they need to produce (a) invitation letter from the organising institute/agency, (ii) participation certificate and any supporting documents within one/two week(s) from the date of participation to the respective institution
- 4.3 A prescribed fee per course shall be payable for condoning shortage of attendance after getting the approval of College Academic Committee for the same. The College Academic Committee shall maintain all the relevant documents along with the request from the students, whose attendance is condoned.
- 4.4 Shortage of Attendance below 65% in any course shall in no case be condoned.**
- 4.5 A Student, whose shortage of attendance is not condoned in any course(s) (Theory/Lab/Mini Project with Seminar) in any Semester, is considered as '**Detained in that course(s)**, and is not eligible to write Semester End Examination(s) of such Course(s), (in case of Mini Project with Seminar, 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 course(s) in subsequent Semesters, and attend the same as and when offered.

4.6 A student shall put in a minimum required attendance in at least FOUR courses in I semester for promotion to II Semester; and at least FOUR courses in II semester for promotion to III Semester.

Re-admission / Re-registration

4.7 A student shall not be permitted to appear for the Semester End Examination (SEE) in a course unless they meet the prescribed attendance requirements for that course. Such students may take readmission for the course in the subsequent semester when it is offered by paying the prescribed fee, *at least 30 days before the commencement of classwork*. The college must obtain permission from the University by submitting the list of students eligible/applied for readmission before the commencement of classwork

4.8 Students who fail due to **less internal marks (less than 50%)** may be extended re-registration and may be permitted during maximum permissible course duration.

4.9 In such a case, the candidate must re-register for the course(s) and secure the required minimum attendance. The candidate's attendance in the re-registered course(s) shall be calculated separately to decide upon eligibility for writing the end examination in those course(s).

4.10 In a semester, students are permitted to re-register maximum of FOUR courses.

4.11 Upon re-registration, the student's previous performance in the respective course(s) will be nullified. Re-registration must be completed by paying the prescribed fee (Rs.XXX/-) at least 30 days prior to the commencement of classwork. The college is required to obtain approval from the University by submitting a list of eligible and interested students before the start of commencement of classwork.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated course-wise, with a maximum of 100 marks for theory and 100 marks for practical, on the basis of Internal Evaluation and End Semester Examination.

5.1 For the theory courses 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The continuous / internal evaluation shall be made based on the **average** of the marks secured in the two CIE/Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each CIE/midterm examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks. End semester examination is conducted for 60 marks for all FIVE (5) questions (one question from one unit) to be answered (either or).

5.2 For practical courses, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks. The internal evaluation based on the day to day work-10 marks, record- 10 marks and the remaining 20 marks to be awarded by

conducting an internal laboratory test. The end examination shall be conducted by the examiners, with breakup marks of Procedure-15, Experimentation- 25, Results-10, Viva-voce-10.

5.3 For Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. Out of 100 marks, supervisor awards 60% marks and remaining 40% marks are awarded by the project review committee.

5.4 A candidate shall be deemed to have secured the minimum academic requirement in a course if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher of the respective college and the ~~second examiner shall be appointed by the University from the panel of examiners submitted by the respective college.~~ second examiner shall be appointed by the Principal from the panel of examiners submitted by the respective HoD

5.8 Students shall undergo mandatory summer internship / industrial training (2 credits) for a minimum of **eight weeks duration** at the end of second semester of the Programme/Summer Break. A student will be required to submit a summer internship/industrial training report to the concerned department and appear for an oral presentation before the committee. The Committee comprises of a HoD / Professor of the department and two faculty. The report and the oral presentation shall carry 40% and 60% weightages respectively. For summer internship / industrial training, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.9 The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering/Specialization in the PG program. Viva will be conducted in 3rd semester. The examination committee will be constituted by the HoD and consist of Professor of the department and two faculty. For comprehensive viva-voce, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

6.0 EVALUATION OF SEMINAR/INTERNSHIP/DISSERTATION WORK

All the students admitted under these regulations have to mandatorily comply the requirements of (i) Seminar-I, (ii) Seminar-II, (iii) Comprehensive Viva, (iv) Dissertation Part-A and (v) Dissertation Part-B. Out of these, (i) to (iv) are evaluated by internally by Project Review Committee (PRC) and (v) External Evaluation.

- 6.1 A Project Review Committee (PRC) shall be constituted with Head of the Department and Two other senior faculty members in the department.
- 6.2 Students are required to appear for Seminar-I and Seminar-II in First and Second respectively. They shall present before PRC on the topic of their choice/interest preferably on the courses listed in respective semesters. PRC shall advise the students in advance to select topics which strengthen their Dissertation Part-A and Dissertation Part-B.
- 6.3 Students shall undergo mandatory summer internship / industrial training (2 credits) for a minimum of eight weeks duration at the end of second semester of the Programme/Summer Break. A student will be required to submit a summer internship/industrial training report to the concerned department and appear for an oral presentation before PRC. The report and the oral presentation shall carry 40% and 60% weightages respectively. For summer internship / industrial training, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.
- 6.4 The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering/Specialization in the PG program. Viva will be conducted in 3rd semester. For comprehensive viva-voce, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.
- 6.5 Registration of Dissertation/Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses, both theory and practical and duly approved by PRC.
- 6.6 After satisfying 6.5, student has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval
- 6.7 If a candidate wishes to change his/her supervisor or topic of the project, he/she can do so with the approval of PRC. However, the PRC shall examine whether or not the change of topic/supervisor 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 Supervisor or topic as the case may be.
- 6.8 Continuous assessment of Dissertation-Part A and Dissertation-Part B during the Semester(s) will be monitored by PRC. *Dissertation-Part A* will be only internal evaluation by PRC for 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.
- 6.9 The candidate shall submit a status report to the PRC in two stages, each accompanied by an oral presentation, with a minimum interval of three months between the two.
- 6.10 The work on the project shall be initiated at the beginning of the III Sem and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis (*Dissertation – Part A & Part B*) only with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate may be allowed to submit the project report if the project work is published or accepted in a reputable national or international journal or conference.

- 6.11 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute along with plagiarism report (<40%).
- 6.10 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.
- 6.11 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is not favourable again, the thesis shall be summarily rejected. The candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the University.
- 6.12 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination. The Board shall jointly report the candidate's work for a maximum of 100 marks. Corresponding grade will be awarded by the University board.
- 6.13 If the report of the Viva-Voce is unsatisfactory (i.e., < 50 marks), the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

7.0 Cumulative Grade Point Average (CGPA)

Marks Range Theory/ Laboratory (Max – 100)	Marks Range Mini Project/ Project Work for Dissertation (Max – 100)	Letter Grade	Level	Grade Point
≥ 90	≥ 90	S	Outstanding	10
≥80 to <90	≥80 to <90	A	Excellent	9
≥70 to <80	≥70 to <80	B	Very Good	8
≥60 to <70	≥60 to <70	C	Good	7
≥50 to <60	≥50 to <60	D	Fair	6
<50	<50	F	Fail	3
			Absent	0

Computation of SGPA

- The following procedure is to be adopted to compute the Semester Grade Point Average(SGPA) and Cumulative Grade Point Average(CGPA):
- The **SGPA** is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA (S_i) = \sum (C_i \times G_i) / \sum C_i$$

- Where C_i is the number of credits of the i th course and G_i is the grade point scored by the student in the i th course.

Computation of CGPA

- The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a Programme, i.e.

$$CGPA = \sum (C_i \times S_i) / \sum C_i$$

- Where S_i is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- Equivalent Percentage = $(CGPA - 0.5) \times 10$

8.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	From the CGPA secured from 80 credits
First Division with Distinction	≥ 7.5 (without supplementary History)	
First Class	≥ 6.5	
Second Class	≥ 6.0 to < 6.5	

The secured grade, grade points, status and credits obtained will be shown separately in the memorandum of marks.

If a student wants to leave the program / exit after successful completion of first two semesters, he/she will be awarded Post Graduate Diploma in the specialization concerned.

9.0 WITHHOLDING OF RESULTS

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

10.0 GENERAL

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES (FOLLOWING WILL BE UPDATED)

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	<i>If the candidate:</i>	
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.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell 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. The Hall Ticket of the candidate is to be cancelled and sent to the University.

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 practicals 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 University 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 University 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.	<p>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 College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.</p>	<p>In case of students of the college, 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.</p>
7.	<p>Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.</p>	<p>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 University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat</p>

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 college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	<p>Student of the colleges 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.</p> <p>Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.</p>
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 University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators:

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
 - (i) A show cause notice shall be issued to the college.
 - (ii) Impose a suitable fine on the college.
 - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

Programme Structure
R25 MTech (XXXX) Structure
MTech (XXXX) I – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 1	3	1	0	4
2		Program Core – 2	3	1	0	4
3		Program Core – 3	3	1	0	4
4		Program Elective – I	3	0	0	3
5		Program Elective – II	3	0	0	3
6		Laboratory – 1	0	1	2	2
7		Laboratory – 2	0	1	2	2
8		Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in I Semester (Electives – I & II)

S.No.	Course Code	Course Title
1		
2		
3		
4		
5		
6		
7		
8		

@ Minimum 2/3 themes per elective

MTech (XXXX) II – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 4	3	1	0	4
2		Program Core – 5	3	1	0	4
3		Program Core – 6	3	1	0	4
4		Program Elective – III	3	0	0	3
5		Program Elective - IV	3	0	0	3
6		Laboratory – 3	0	1	2	2
7		Laboratory – 4	0	1	2	2
8		Seminar – II	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Code	Course Title
1		
2		
3		
4		
5		
6		
7		
8		

@ Minimum 2/3 themes per elective

MTech (XXXX) - III Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / <i>Swayam 12 week MOOC course – RM&IPR</i>	3	0	0	3
2		Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3		Comprehensive Viva [#]	-	-	-	2
4		Dissertation Part – A ^{\$}	-	-	20	10
		TOTAL	3	-	20	18

* Student attended during summer / year break and assessment will be done in 3rd Sem.

Comprehensive viva can be conducted courses completed upto second sem.

\$ Dissertation – Part A, internal assessment

MTech. (XXXX) – IV Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Dissertation Part – B [%]	-	-	32	16
		TOTAL	-	-	32	16

% External Assessment

Revised Bloom's Taxonomy Action Verbs

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	<ul style="list-style-type: none"> Choose Define Find How Label List Match Name Omit Recall Relate Select Show Spell Tell What When Where Which Who Why 	<ul style="list-style-type: none"> Classify Compare Contrast Demonstrate Explain Extend Illustrate Infer Interpret Outline Relate Rephrase Show Summarize Translate 	<ul style="list-style-type: none"> Apply Build Choose Construct Develop Experiment with Identify Interview Make use of Model Organize Plan Select Solve Utilize 	<ul style="list-style-type: none"> Analyze Assume Categorize Classify Compare Conclusion Contrast Discover Dissect Distinguish Divide Examine Function Inference Inspect List Motive Relationships Simplify Survey Take part in Test for Theme 	<ul style="list-style-type: none"> Agree Appraise Assess Award Choose Compare Conclude Criteria Criticize Decide Deduct Defend Determine Disprove Estimate Evaluate Explain Importance Influence Interpret Judge Justify Mark Measure Opinion Perceive Prioritize Prove Rate Recommend Rule on Select Support Value 	<ul style="list-style-type: none"> Adapt Build Change Choose Combine Compile Compose Construct Create Delete Design Develop Discuss Elaborate Estimate Formulate Happen Imagine Improve Invent Make up Maximize Minimize Modify Original Originate Plan Predict Propose Solution Solve Suppose Test Theory



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I Year - I Semester	Program Core1	L	T	P	C
		3	1	0	4
APPLIED HYDROLOGY					

Pre-Requisites: NONE Course Outcomes:

At the end of the course, the student will be able to

CO1	Analyze components of hydrologic cycle
CO2	Predict hydrologic extreme events for hydraulic and hydrologic design
CO3	Develop forecasting models for operation of hydrologic systems
CO4	Assess surface water resources

CO-PO mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	3		1
CO2	1		2	3	1	3
CO3	1		3	3		2
CO4	1		2	3		1

Syllabus:

Unit	Contents	Contact Hours
Unit - 1	<p>Introduction: Description of Hydrologic Cycle, Overview of application of hydrology in engineering, Historical aspects of development of hydrology, Eco-hydrology</p> <p>Precipitation: Characteristics of precipitation in India, Measurement of precipitation, rain gauge network, collection and presentation of rainfall data, analysis of rainfall data, intensity duration-frequency analysis and depth-area-duration analysis, development of design storms for typical regions in data scarce environment</p>	



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Unit – 2	<p>Abstractions from Precipitations: Evaporation and Evaporation Process, measurement, estimation and control of evaporation, Evapotranspiration, measurement and estimation of evapotranspiration, interception and depression storage, Infiltration process, measurement of infiltration, infiltration models and infiltration indices and effective rainfall, Corps of Engineers Procedure for developing effective rainfall hyetograph, Eco-hydrology</p> <p>Precipitation: Characteristics of precipitation in India, Measurement of precipitation, rain gauge network, collection and presentation of rainfall data, analysis of rainfall data, intensity duration-frequency analysis and depth-area-duration analysis, development of design storms for typical regions in data scarce environment</p>	
Unit - 3	<p>Stream flow Measurement: Streamflow measurement, stage-discharge relationship and rating curve, Runoff characteristics, catchment characteristics affecting the runoff, yield from a catchment, flow duration curve and flow mass curve</p> <p>Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models - synthetic unit hydrograph and its derivation</p>	
Unit - 4	<p>Flood Estimation: Peak discharge estimation procedures, deterministic and probabilistic approaches, enveloping curve, rational method, SCS and unit hydrograph methods, Design flood, return period, flood frequency analysis, probabilistic and statistical concepts, and time series analysis, Gumbel's and log Pearson Type III methods</p>	
Unit - 5	<p>Flood Routing: Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting Learning Resources, , introduction to Dam breach Analysis and Levee Analysis</p>	

Textbooks:

1. Applied Hydrology, Chow, V.T., Maidment, D.R., and Mays, L.W., Tata mcgraw Hill Edition, 2017 2nd Edition
2. Engineering Hydrology, Subramanya, K., Tata mcgraw Hill Publications, 2017 4th Edition 3. Hydrologic Analysis and Design, McCune, R.H., Pearson Publications, 2017 4th Edition Reference Books:

Reference:

1. Water Resources Engineering, Mays, L.W., Wiley Publications, 2019 3rd Edition
2. Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008 5th Edition



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I Year - I Semester	Program Core2	L	T	P	C
		3	1	0	4
REMOTE SENSING AND GIS					

Course Outcomes: At the end of the course, the student will be able to

CO1	Basic concept of introduce the technology and principles of Remote Sensing
CO2	Understanding the theoretical explanations on Image processing and information extraction from Satellite Data Products
CO3	Knowledge about GIS mapping, editing and modeling
CO4	Analyze the spatial data analysis
CO5	Explain about remote sensing and GIS is solving problems in water resources through case studies.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	-	2
CO2	3	2	3	-	1
CO3	3	2	3	-	3
CO4	3	2	2	-	1
CO5	3	3	3	-	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Remote Sensing: Definition, Elements involved in Remote Sensing, Nature of Electromagnetic radiation, Electromagnetic spectrum, Energy interaction with earth features-vegetation, soils and water bodies, energy interaction in the atmosphere, Spatial resolution, Spectral resolution and Radiometric resolution, characteristics of various sensors and satellites: LANDSAT, IRS, SENTINEL	
Unit-2	Image analysis: Introduction; Elements of visual Image Interpretation, Digital image processing - radiometric and geometric corrections, Image enhancement, Image classification, Supervised classification, Unsupervised classification, Accuracy Assement	



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Unit-3	Geographic Information System: Introduction to GIS, Key Components of GIS, Overview of GIS, Map projections, GIS editing, GIS modeling.	
Unit-4	Spatial Data input and analysis: Introduction, spatial data input, raster data models, vector data models, raster versus vector, overlay functions-vector overlay operations, raster overlay operations, network analysis	
Unit-5	RS&GIS Applications in Water Resources: land cover and land use, land use and land cover classifications, role of satellite remote sensing in water resources management, surface water monitoring and mapping, Ground water prospects, reservoir management and flood management	

Textbooks:

1. Introduction To Geographic Information Systems – Kang Tsung Chang, tatamc.G.H. Publications, New Delhi.
2. Fundamentals of Remote Sensing 2nd Ed – George Joseph, University Press, New Delhi
3. Lillesand, T.M. And Kieffer, Remote Sensing and Image Interpretation, Joh Wiley and Sons, New York, 1987.
4. Fundamentals of GIS by Micheal N Demers In Mc Grahill Publications

Reference Books:

1. Remote Sensing of The Environment – An Earth Resource Perspective – John R. Jensen, Pearson Education, New Delhi.
2. Aronoff, S. 1989. Geographic Information Systems: A Management Perspective. Ottawa: Wdl Publications.
3. Bonham – Carter, G, F. 1994. Geographic Information Systems for Geoscientists: Modeling with Gis. New York: Pergamon Press.
4. Burrough, P.A And R.A. Mcdonnell. 1998. Principles Of Geographical Information
5. Systems. Oxford: Oxford University Press.
6. Lo, C.P., And Albert K.W. Young Concepts and Technologies of Geographic Information Systems, Prentice Hall of India (Pvt) Ltd, New Delhi.



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I Year – I Semester	Program Core 3	L	T	P	C
		3	1	0	4
DESIGN OF HYDRAULIC STRUCTURES					

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyze and design earth and rockfill dams
CO2	Analyze and design gravity dams
CO3	Design spillways and energy dissipation structures
CO4	Explain the principles of hydraulic modeling

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2	3	
CO2	1		3	2	3	
CO3	1		3	1	3	2
CO4	1		2		3	

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction: Hydraulic structures for water resources projects. Types of hydraulic structures, storage, diversion, conveyance and distribution structures, capacity of a reservoir, reservoir silting, types of dams	
Unit-2	Hydraulic structures on permeable foundations, seepage theories, Khosla's theory, design of diversion headworks and other structures on permeable foundations	
Unit-3	Embankment Dams: Types, design considerations, seepage analysis and control, stability analysis, construction techniques	
Unit-4	Gravity Dams: Forces acting on failure of a gravity dam, stress analysis, elementary profile, design of gravity dam, other functional features of a gravity dam	
Unit-5	Dam Outlet Works: Types of outlet structures, ogee spillway, chute spillway, siphon spillway, side channel spillway, Labyrinth and Piano-key weir. Terminal Structures: Hydraulic jump types, stilling basin, roller bucket, ski jump basin, baffled spillway, drop structure Hydraulic Modeling: Basic principles, dimensional analysis, modelling free-surface flows, design of physical models	



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Learning Resources:

Textbooks:

1. Irrigation, Waterpower and Hydropower Engineering, Arora K. R., Standard Book Publishing, New Delhi, 5th Edition, 2018
2. Irrigation Water Resources and Hydropower Engineering, Modi, P. M., Standard Book Publishing Company, New Delhi, 9th Edition, 2014
3. Hydraulic Structures, Novak, P. And Nalluri, C., Taylor & Francis. 2007 Edition 4.
4. Irrigation and Water Resources Engineering, Asawa G.L., New Age International Publishers, New Delhi, 2006
5. Embankment Dam and Engineering, Singh, B., and Varshney, R.S., Nem Chand and Brothers. 2004.
6. Earth and Rockfill Dams, Bharath Singh and Sharma, H. D., Saritha Prakashan, 1976.

Reference Books:

1. Water Resources Engineering – Principles and Practice, Murthy, C.S.N., New Age International Publishers, New Delhi, 2020nd Edition
2. Concrete Dams, Sharma, H.D., CBIP Publication, 1998.
3. Hydraulic Design of Stilling Basins and Energy Dissipators, Peterka, A.J, USBR Engineering Monographs No. 25". 1984

Online Resources:

1. <https://www.routledge.com/IAHR-Design-Manual/book-series/TFIAHRHSDM>



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I Year - I Semester		L	T	P	C
	Program Elective 1	3	1	0	3
(a) ADVANCED FLUID MECHANICS					

Pre-requisite:

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Basic concepts of mathematical and physical background to analyze real life problems in fluid mechanics	
CO2	Understanding of possess skills to take up research activities involving fluid motions	
CO3	Develop the boundary layer concept on fluid motion	
CO4	Analyze the irregular fluid in motion	
CO5	Explain about the basic concept of Hydraulic Transients	

#Based on suggested Revised BTL

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	1	-	-	
CO2	-	2	2	-	-	
CO3	-	-	2	-	-	
CO4	-	1	3	-	-	
CO5	-	2	3	3	1	

Mapping of course outcomes with program outcomes

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Kinematics of Flow: Description of fluid motion - Lagrangian and Eulerian approaches, Equations of continuity, energy and linear momentum in Cartesian and polar coordinates, Standard 2D Flow Patterns: Uniform flow, Source, sink, vortex, doublet and their combinations, D'Alembert's paradox	



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Unit-2	Laminar Flow: Derivation of Navier-Stokes equations – exact solutions for flow between parallel plates, Hagen Poissulle flows, Couette flow, velocity, shear stress and pressure distribution, flow near a suddenly accelerated plate and an oscillating plate.	
Unit-3	Boundary Layers: Boundary layer equations, Boundary layer thickness boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Karman-Puhlhausen approximate solution, separation in boundary layer under adverse pressure gradient, turbulent boundary layer	
Unit-4	Turbulent Flows: Reynolds equations of motion, semi-empirical theories of turbulence, Prandtl mixing length, velocity profiles for inner, outer and overlap layers, shear stress and pressure distribution, equilibrium boundary layers	
Unit-5	Hydraulic transients: Basic concepts- transient flow equation, transient in pumping systems, transient in hydroelectric power plants, cavitation, water hammer, surges and their protection work	

Textbooks:

1. Foundations of Fluid Mechanics by S W YUAN
2. Fluid Mechanics by White
3. Fluid Mechanics by Hunter and Rose
4. Fluid Mechanics by C S P Ojhha
5. Boundary layer theory by Schlichting H
6. Applied Hydraulics of pumps by Tullis, Hydraulic Transients by Hanif Choudhary



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I Year - I Semester		L	T	P	C
	Program Elective 1	3	1	0	3
(b)Advanced Numerical Methods and Applied Statistics					

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Numerical Integration and Differentiation Newton-Cotes Integration Formulas: The Trapezoidal rule, Simpson's rules, Integration with unequal Segments, Open Integration Formulas, Multiple Integrals. Integration of Equations: Newton-Cotes Algorithms for Equations, Romberg Integration, Adaptive Quadrature, Gauss Quadrature, Improper Integrals. Numerical Differentiation: High-Accuracy Differentiation Formulas, Richardson Extrapolation, Derivatives of Unequally Spaced Data, Derivatives and Integrals for Data with Errors, Partial Derivatives, Numerical Integration/Differentiation with Software Packages.	
Unit-2	Ordinary Differential Equations Explicit and Implicit Forms of Difference Equations, Taylor's and Euler's Methods, Runge-Kutta Methods, Systems of Equations, Adaptive Runge-Kutta Methods, Stiffness of odes& Multi step methods, Gear's Algorithm, Finite Difference Technique for Boundary Value Problems (BVP), derivative boundary conditions, convergence and stability of finite difference schemes.	
Unit-3	Finite element method Finite-Element Method: The General Approach, Finite-Element Application in One Dimension Two-dimensional Problems, Solving pdes with Software Packages.	
Unit-4	Application of Statistical Methods Joint probability distributions, marginal distributions, conditional distribution, statistical independence. Reliability applications: Failure rate, exponential law, Weibull law, Reliability of a component, system reliability, parallel and series reliability	



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TEXTBOOK:

1. "Numerical methods for engineers"; Steven C. Chapra, Raymond P. Canale; mcgraw Hill higher education, 6th edition, 2010.
2. "Probability and Statistics for Engineers and Scientists"; Ronald E. Walpole, Sharon L. Myers and Keying Ye; Pearson, Eighth edition.

REFERENCE BOOKS:

1. "Mathematical Methods in Chemical Engineering"; Jenson V.G. and Jeffreys G.V; Academic press, 2nd edition.
2. "Advanced Engineering Mathematics"; Erwin Kreyszig, Wiley-India publication, 8th edition.
3. "Introductory Methods of Numerical Analysis", Sastry S.S; 4th Edition, PHI Learning Pvt. Ltd., 2006.



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I Year – I Semester	Program Elective 1	L	T	P	C
		3	1	0	4
(c) LAND AND WATER MANAGEMENT					

Course Outcomes: At the end of the course, the student will be able to

CO1	Plan irrigation systems and command area development programs
CO2	Evaluate performance of an irrigation system
CO3	Plan measures for reclamation of waterlogged lands
CO4	Develop strategies for conflict management in irrigation projects

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	3	1
CO2	1		3	1	3	1
CO3	1		3	1	3	1
CO4	1		3	1	3	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction – Need for proper management of land and water resources. Planning of irrigation projects – Inadequacies in present approaches in canal irrigation management – command area development programs.	
Unit-2	Classification of irrigable soils – soils-plant-water relationships – soil management Irrigation management – Irrigation Management Matrix – Society and irrigation – perceptions of various stake holders on irrigation system performance	
Unit-3	Macro and precision irrigation, Diagnostic analysis of irrigation systems – performance indicators for performance evaluation of irrigation projects Water logging and salinity – water quality for irrigation	
Unit-4	Participatory irrigation management – Farmer's management of irrigation system acts - conflict resolution	
Unit-5	Legal aspects in water sharing and management – PC-CP - case studies	



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Learning Resources:

Textbooks:

1. Irrigation Water Management, Majumdar, D.K., Prentice Hall of India, New Delhi, 2013, 2nd Ed.
2. Irrigation: Theory and Practice, Michael, A.M., Vikas Publishing House Pvt. Ltd. New Delhi, 2009

Reference Books:

1. Land and Water Management Engineering, Murthy, V.V.N., Kalyani Publishers, Ludhiana, 2011
2. Soil and Water Management Systems, Swabe, G.O., Fangmeir, D.D., and Elliot W.J., John Wiley and Sons, N York, 1996

Online Resources:

1. https://www.iima.ac.in/c/document_library/4participatoryirrigation8f9a.pdf?Uuid=a5eced82-3f75-4068-9aa1-57aef9de0876&groupid=62390
2. <https://www.iwapublishing.com/news/integrated-water-resources-management-basicconcepts>
3. <https://www.indiawaterportal.org/articles/introduction-integrated-water-resourcemanagement-iwrm-open-courseware-united-nations>



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I Year - I Semester		L	T	P	C
	Program Elective 1	3	1	0	3
(d) Environmental Impact Assessment and Management					

Pre-requisites: NONE

Course Outcomes:

CO1	Identify environmental attributes for the EIA study.
CO2	Identify methodology and prepare EIA reports.
CO3	Specify methods for prediction of the impacts.
CO4	Formulate environmental management plans.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	3	-
CO2	2	1	1	1	3	-
CO3	2	2	3	1	3	-
CO4	2	2	2	2	2	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction: Definitions – Environmental Inventory, Standards, Indices – Environmental attributes—Air, Water Noise, Land Economic; Cultural and detailed discussions of individual parameters of each attribute; methods for Prediction and assessment of impacts air – water – soil – noise – biological – cultural – social – economic environments - Standards and guidelines for evaluation.	
Unit-2	EIA - EIA Terminology – Need for EIA – Evolution of EIA – Concepts of EIA – Merits and demerits of EIA – Procedures – Screening, Scoping baseline data, Impact prediction – Stake holders of EIA – Public Participation in Decision making – Projects requiring Environmental Clearance	
Unit-3	EIA methodologies – Criteria for Selection -Impact identification, measurement, interpretation and Evaluation – Impact Communication – Adhoc Methods, Checklists Methods, matrices, Networks and Overlays Methods – Cost-Benefit Analysis – Rapid EIA and Comprehensive EIA – General Framework for Environmental Impact Assessment, Characterization and site assessment	



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Unit-4	EMP and Monitoring – Document Planning – Scope and Baseline conditions – Construction Stage Impacts – Environmental Management Plan – Identification of significant or Unacceptable Impacts – Environmental Mitigation Plans – Relief and rehabilitation – Environmental Legislation and Audit – Concept of Environmental Risk Analysis and Life Cycle Assessment – Legal and regulatory Aspects in India.	
Unit-5	EIA Case Studies of Developmental Projects: Preparation of EIA for developmental projects - Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Mining, Nuclear fuel complex, Highway project, Sewage treatment plant, CETP, Treatment Storage Disposal Facility, Municipal Solid waste processing plant, Tannery industry. Software for rapid EIA, introduction funding agency guidelines	

TEXTBOOKS:

1. Canter, L.W., Environmental Impact Assessment, mcgraw Hill Pub. Co., 1997
2. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
3. Anjaneyulu., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.

REFERENCE BOOKS:

1. Barthwal, R. Environmental Impact Assessment, New Age International Publishers, 2002
2. Rau, J.G. and Wooten, D.C, Environmental Impact Assessment, mcgraw Hill Pub. Co., New York, 1996.
3. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.
4. Hosetti, B. B, Environmental Impact Assessment & Management, Kumar A, Eds, Daya Publishing House, 1998
5. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987 8. EIA Notification 2016

Other Suggested Readings:

1. [MEVE-001: Environmental Impact Assessment for Environmental Health – Course \(swayam2.ac.in\)](http://MEVE-001: Environmental Impact Assessment for Environmental Health – Course (swayam2.ac.in))
2. [120108004.pdf \(nptel.ac.in\)](http://120108004.pdf (nptel.ac.in))
3. Environmentclearance.nic.in/writereaddata/Form-1A/homelinks/ommodel2.html
4. Environmentclearance.nic.in/writereaddata/Form-1A/homelinks/ommodel3.html



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I year - I Semester		L	T	P	C
	Program Elective 2	3	1	0	3
(a) INTEGRATED WATERSHED MANAGEMENT					

Course Outcomes: At the end of the course, the student will be able to

CO1	Classify and Prioritize Watersheds for Watershed Management
CO2	Plan and design soil conservation measures in a watershed
CO3	Plan and design water harvesting and groundwater recharge structures
CO4	Plan measures for reclamation of saline soils

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2	1	1
CO2	2		3	1	3	2
CO3	2		3	1	3	2
CO4	2		3	1	3	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction to Watershed and Watershed Management, Problems and Prospects in Watershed Management, History of Watershed Management in India, Land classification and Watershed based land use planning, Planning for Watershed Management, Participatory watershed management	
Unit-2	Watershed Characteristics: Physical and Geomorphologic Factors affecting Watershed Management, Watershed Characteristics: Classification and Measurement, Importance of Watershed Properties for Watershed Management, Prioritizations of Watersheds.	
Unit-3	Hydrology in soil and water conservation, Hydrologic Data for Watershed Planning, Rainfall Runoff relationships, Water Yield Assessment and Measurement from Watersheds	



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Unit-4	Principles of soil erosion, Soil Erosion Mechanism, Estimation of soil loss from small watersheds, Measurements and Estimation of Sediment Yield, Soil Erosion Control Measures – Engineering and Agronomical.	
Unit-5	Water Harvesting Concepts and Methods, Principles of water harvesting, methods of rainwater harvesting, Rainwater Conservation Technologies and Water Harvesting Structures, Farm Ponds, Earthen Dams, Artificial recharge of groundwater in small watersheds, methods of artificial recharge. Salt Problems in Soil and Water, Classification of Salt Affected Soils, Reclamation of Saline Soils.	

Learning Resources:

Textbooks:

1. Watershed Management, Murthy, J.V.S., New Age International Publishers, 2017 2nd Edition
2. Land and Water Management, Murthy, V.V.N., and Jha, M.K., Kalyani Publishers, 2013 6th Edition

Reference Books:

1. Soil and Water Conservation Engineering, Suresh, R., Standard Publishers, 1998
2. Water Resources Conservation and Management, Chatterjee, S.N., Atlantic Publishers, 2008
3. Common Guidelines for Watershed Development Projects, Government of India, 2008

Online Resources:

1. <https://nptel.ac.in/courses/105/101/105101010/>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=542>



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I Year - I Semester	Program Elective 2	L	T	P	C
		3	1	0	3
(b) Water Resources Systems Planning and Management					

Course Outcomes: At the end of the course, the student will be able to

CO1	<ul style="list-style-type: none"> * Understand the priorities for allocation of water. * Meeting challenges in management of available water resources. * Appraisal of various strategies for planning of water resources projects. * Steps involved in implementation of water resources projects.
CO2	<ul style="list-style-type: none"> * Appraisal of welfare economics related to water resources projects. * To estimate the cost of a water resources project. * Allocation of cost among various purposes in a multi-purpose project. * Carrying out the cost-benefit analysis for selection of a water resources and alternatives based on incremental cost-benefit analysis.
CO3	<ul style="list-style-type: none"> * Need for an integrated water resources management (IWRM) * Understanding the importance of systems approach in water resources planning and management. * River basin system and various sub-systems. * System decomposition and modelling of water resources systems.
CO4	<ul style="list-style-type: none"> * Understanding the importance of optimization in water resources planning and management. * Different techniques of optimization for water resources system analysis. * Linear programming concepts - Graphical method, Simplex method, Big M method.
CO5	<ul style="list-style-type: none"> * Impart the significance of dynamic programming in water resources systems analysis. * Multi-objective optimization. * Examples of river basin planning and management.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	1	-
CO2	-	-	3	1	-
CO3	1	-	2	2	2
CO4	1	1	2	3	2
CO5	2	-	2	2	2



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Syllabus:

Unit	Contents	Contact Hours
Unit-1	<p>General Introduction to Water Resources Planning & Management.</p> <p>Introduction: Water Resource Potential & Future Demand. Water Resources Development - Purposes Served. Planning & Management Approaches - National Water Policy - Water Allocation Priorities. Water Resources Project Planning Process - Planning of Water Resources Projects for various purposes - Meeting Challenges - Water Resources Planning Strategies. Project Planning for Domestic Water Supply, Irrigation Water Supply, Hydropower generation, flood control. Miscellaneous other projects - Ecology restoration, Industrial Water supply, Navigation. Implementation of Water Resources Projects - Steps Involved</p>	
Unit-2	<p>Economics of Water Resources Projects</p> <p>Basic Concepts of Engineering Economics - Welfare Economics. Definition of Terms Related to Costs - Various costs of a project - Project Costs, Associated Costs and Working Costs. Cost Allocation and Cost Benefit Analysis - Allocation of Costs among components of Multipurpose projects: (i) Remaining Benefits Method, (ii) Alternative Justifiable Expenditure Method and (iii) Facilities Used Method. Total Economic Value of Projects. Project Analysis. Study of Alternatives - Steps involved in decision making - Cost Estimates of Project - Parameters influencing - Capital Recovery Factor (CRF) - Project Life. Cost comparison of alternatives - Various Cost-Benefit Ratios (CB Ratios) Incremental Cost Benefit Analysis - Project selection</p>	
Unit-3	<p>Integrated Water Resources Management (IWRM) & Systems Approach.</p> <p>Introduction to Integrated Water Resources Management (IWRM): Integrative Nature of River Basins - Challenges and Actions to be taken - Planning and Management Approaches - Technical, Economic and Institutional aspects in planning and management. System Approach - Definition of System - System Concept - Need, Advantages and Disadvantages of Systems Approach. - Examples of problems - Techniques in WRS Analysis - System Components - Types of Systems. River Basin System: Typical</p>	



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	Water Resources System - Sub-system (i) Reservoir Design and Operation, (ii) Real Time Operation for Flood Control, (iii) Optimal Groundwater Development, (iv) Multi-reservoir Systems, (v) Interlinking of Basins, (vi) Conjunctive use of surface and Groundwater, (viii) Water quality in streams (ix) Hydropower Systems. Systems Analysis - Water Resources System Analysis - System Representation in Water Resources Planning and Management - System Decomposition. Modelling of Water Resources Systems.	
Unit-4	Optimization Techniques in Water Resources Management. Introduction to Optimization: Engineering Applications of Optimization – Basic Concepts of Optimization - Types of Optimization Techniques. Basic Components of Optimization Problem - Objective function - Variables and Constraints – Optimization by Method of Calculus – Stationary Points, Functions of Single and Two Variables – Sufficient and Necessary Conditions - Convex and concave functions. Constrained and Unconstrained Optimization – Optimization through Linear Programming –Standard form of LP - Canonical Form - Elemental and Pivotal Operations - Transformation to Canonical Form - Graphical and Simplex Methods of LP. - Big M Method - Duality of LP problems. Sensitivity.	
Unit-5	Applications Dynamic Programming, Simulation and Water Resources Systems Modelling. Introduction and preliminaries: Dynamic Programming Models - Classical Optimization Techniques - Non-linear Programming, Gradient Techniques, Genetic Algorithm, Stochastic Programming, Simulation, Search Techniques, Multi Objective Optimization. Water Allocation - Capacity Expansion - Reservoir Operation. Multi-objective Optimization - Multipurpose Reservoir Operation. Simulation & Modelling - River Basin Simulation - Reservoir Operation Simulation. Water Resources Systems Modelling - River Basin Planning and Management - Some Examples: (i) Water Distribution System, (ii) Groundwater System, (iii) Water Quality Modelling, (iv) Flood Plain Management and (v) Urban Storm Water Management.	



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Textbooks:

1. Water Resources Systems - Modelling Techniques and Analysis by S. Vedula and P. P. Mujumdar
2. Water Resources Systems Planning and Management – An Introduction to Methods, Models and Applications by Daniel P. Loucks and EELCO VAN BEEK
3. Economics of Water Resources Planning by L. Douglas James and Robert R. Lee
4. Economic Analysis of Water Resources by Mc Kinney
5. Water Resources Systems Planning - Some Case Studies for India by Mahesh C. Chaturvedi and Peter Rogers.



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I Year - I Semester	Program Elective 2	L	T	P	C
		3	1	0	3
(c) Data Analytics in Water Resources					

It is advised to use any data handling software such as 'MATLAB' or 'R' to demonstrate / illustrate the concepts discussed in each unit.

Course Outcomes: At the end of the course, the student will be able to

CO1	Know how to represent various forms of data, and perform basic data interpretation tasks
CO2	Represent and analyze spatially distributed datasets (data that vary in spatial domain)
CO3	Represent and analyze temporally distributed datasets (data that vary in time domain)
CO4	Perform statistical and hypothesis tests on data for use with decision making
CO5	Explore novel and advanced techniques for data analysis with emphasis in water resources

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Data Representation and Processing: Data forms and representation methods; Representation of graphical data; Analysis of missing data and data gaps; Qualitative and quantitative methods of data interpretation; Data visualization techniques; Random variables and probability distributions.	
Unit-2	Spatial Data Analysis: Sampling distributions; Spatial data interpolation – deterministic and probabilistic methods; inverse distance weight (IDW) method; semi-variogram concepts; kriging; Spatial statistics.	
Unit-3	Temporal Data Analysis: Statistical metrics for evaluation; Data classification with time series; Time series data visualization techniques; Stationarity and non-stationarity in time-series; Autoregression; Moving average; ARMA models, Time series forecasting; nowcasting; hindcasting.	



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Unit-4	Hypothesis Testing: Null and alternative hypothesis; Significance level; Test statistic; Critical value approach; P-value approach; Type 1 and Typ2 errors; Numerical problems in Water resources concerning one- and two-tailed hypothesis testing; Rank-sum test.	
Unit-5	Advanced Techniques for Data Analysis: Correlation; Simple linear regression; Multiple linear regression; Trend analysis; artificial intelligence (AI) and machine learning (ML) in water resources	

Textbooks / References

- 1) Helsel, D.R., Hirsch, R.M., Ryberg, K.R., Arch field, S.A., and Gilroy, E.J., 2020, *Statistical methods in water resources: U.S. Geological Survey Techniques and Methods*, book 4, chapter A3, 458 p., <https://doi.org/10.3133/tm4a3>
- 2) Statistical hypothesis testing: Theory and Methods by Ning-Zhong Shi and Jian Tao
- 3) Statistical methods in hydrology and Hydrometeorology by Rajib Maity – Springer Transactions in Civil and Environmental Engineering



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I Year – I Semester	Program Elective 2	L	T	P	C
		3	0	0	3
d) Industrial Wastewater Treatment					

Course Learning 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.

Course Outcomes:

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

- a. Know the quality and quantity of water for various industries and Advanced water treatment methods
- b. Learn the common methods of treatment of wastewaters and Biological treatment methods
- c. Study of methods to reduce impacts of disposal of wasters into environment and CETPs.
- d. Study of methods of treatment of wastewaters from specific industries like steel plants, refineries, and power plants, that imply biological treatment methods
- e. Study of methods of treatment of wastewaters from industries like Aqua, dairy, sugar plants, and distilleries that imply biological treatment methods

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	1	1	3	-	-	1	-	-	-	-	-	1
CO3	3	3	3	3	-	-	3	2	1	-	2	-	-	1	3	-
CO4	3	3	3	-	-	-	3	2	1	-	2	-	-	1	3	-



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Unit	Contents	Contact Hours
Unit-1	Industrial water Quantity and Quality requirements: Boiler, Cooling, Domestic/Canteen and Process waters for Textiles, Food processing, Dairy, Aqua industry, Sugar mills, Brewery and distillery Industries, Fertilizer industry, Power plants. Advanced water treatment - Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour. Use of Municipal wastewater in Industries, water in mining, agriculture and construction	
Unit-2	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, ZLD, design of piping for water mains & sewers in resorts and industries, flow meters	
Unit-3	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-4	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. 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, compliance report – CFE/CFO wastewater as a renewable source, maintenance of SS tanks & ponds, wastewater economics.	



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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, New Delhi.
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; 3rd Edition

References

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition
2. Wastewater Engineering by Metcalf and Eddy Inc, Tata McGrawhill Co., 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.



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I Year - I Semester	Laboratory 1	L	T	P	C
		0	1	2	2
GEOGRAPHICAL INFORMATION SYSTEMS APPLICATIONS LABORATORY					

Course Outcomes: At the end of the course, the student will be able to

CO1	Prepare the different geospatial layers
CO2	Compute geometric measurements and perform spatial analysis
CO3	Create high-quality maps and associated graphics
CO4	Integrate different geospatial layers

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2		
CO2	1	2	3	3		1
CO3	1	2	3	3		
CO4	1	2	3	2		

Syllabus

Unit	Contents	Contact Hours
	1. Downloading and Importing maps and Data from various online resources for water resources applications 2. Georeferencing and projection 3. Digitization of Points, Lines and polygons. 4. Buffer Analysis 5. Network Analysis 6. Generation of TIN and DEM 7. Watershed delineation and Morphometric Analysis 8. Rainfall Interpolation 9. Spectral Indices - NDVI, NDWI. 10. Unsupervised classification of remote sensed data 11. Supervised Classification of remote sensing data. 12. Accuracy assessment using kappa coefficient	



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Syllabus:

Learning Resources:

Textbooks:

ArcGIS user manuals and QGIS User Manuals

Online Resources:

https://docs.qgis.org/2.8/en/docs/training_manual/processing/hydro.html

<https://hatarilabs.com/ih-en/watershed-and-stream-network-delineation-on-large-scalebasins-with-qgis-3-tutorial>

<https://support.esri.com/en/technical-article/000012346>

I Year - I Semester		L	T	P	C
	Laboratory 1	0	1	2	2
ADVANCED FLUID MECHANICS LAB					

Course Outcomes: At the end of the course, the student will be able to

CO1	Prepare the different geospatial layers
CO2	Compute geometric measurements and perform spatial analysis
CO3	Create high-quality maps and associated graphics
CO4	Integrate different geospatial layers

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2		
CO2	1	2	3	3		1
CO3	1	2	3	3		
CO4	1	2	3	2		



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List of Experiments:

Exposure to software's such as ANSYS, FLUENT, creation of Geometry, Mesh, description of boundary condition and solution of flow problems in 1D, 2D and 3D. Typical examples should include Dams and pipes

- Static & Dynamic analysis of concrete gravity dams using ANSYS APDL
- Seepage analysis of concrete gravity dams using ANSYS APDL
- Seismic analysis of concrete gravity dam ANSYS APDL
- Crack analysis of concrete gravity dam ANSYS APDL
- Laminar flow analysis using CFD
- Turbulent flow analysis using CFD



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SEMESTER II**

I Year - II Semester	Program Core 4	L	T	P	C
		3	1	0	4
URBAN HYDROLOGY					

Course Outcomes: At the end of the course, the student will be able to

CO1	Basic concepts of Urban Hydrological cycle and effect of urbanization on hydrology
CO2	Understanding the basic concepts of precipitation analysis
CO3	Knowledge about the methods of quantity estimation of storm water
CO4	Analyze the Infrastructure for storm water management
CO5	Explain about the Study the process of urbanization and its influence on urban hydrological processes and urban water supply system including, storm water modeling.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	-	2
CO2	3	3	3	-	2
CO3	-	3	3	1	2
CO4	-	1	3	-	2
CO5	3	3	3	-	2



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Unit	Contents	Contact Hours
Unit-1	Introduction: Urbanization and its effect on water cycle – urban hydrologic cycle – trends in urbanization – Effect of urbanization on hydrology, need for urban drainage system, population forecasting	
Unit-2	Precipitation Analysis: Importance of short duration of rainfall and runoff data, methods of estimation techniques for urban drainage systems, Intensity-Duration -Frequency (IDF) curves, design storms for urban drainage systems	
Unit-3	Quantity Estimation of Storm Water: Factors Affecting the Quantity of Storm water, Methods for Estimation of Quantity of Storm Water, Time of Concentration, zoning and runoff coefficient, peak flow estimation approaches -Rational method, NRCS curve number approach, Empirical formulae	
Unit-4	Infrastructure for Storm Water Management: conventional drainage systems, underground drains, sustainable drainage systems, Requirements for Urban Drainage Design, Operation and Maintenance, source control	
Unit-5	Analysis and Management: Storm water drainage structures, Sewer appurtenances, design of storm water network- Best Management Practices–detention and retention facilities, constructed wetlands, models available for storm water management, Water conservation systems, inlets, pumping, guidelines for road drainage system, introduction to regulations	

References:

- Urban Drainage, David Butler and John W. Davies, Spon press an imprint of Tylor & Francis, London and New York.
- Report on Storm water Management, Adrián Morales Torres IIAMA - Universitat Polytechnic de València, Sara Perales Momparler Green Blue Management
- National Disaster Management Guidelines, Management of Urban flooding, National Disaster Management Authority of India
- Design guidelines for storm water drainage system (Ministry of Housing and Urban Affairs Manual: Part A – Engineering, Part B – O&M, Part C – Management)



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I Year - II Semester	Program Core 5	L	T	P	C
		3	1	0	4
GROUND WATER ENGINEERING					

Course Outcomes: At the end of the course, the student will be able to

CO1	Basic concepts of Role of ground water in hydrological cycle and aquifer properties
CO2	Understanding the governing equations of Ground water flows
CO3	Knowledge about the impacts exposure towards well design and practical problems of ground water aquifers
CO4	Analyze the Ground water conservation and Ground water quality
CO5	Explain about Ground water flow modeling

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	1
CO2	3	3	3	-	2
CO3	3	3	3	-	3
CO4	3	3	3	-	2
CO5	2	2	3	-	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction: Role of groundwater in hydrological cycle, groundwater bearing formations, classification of aquifers, flow and storage characteristics of aquifers, Darcy's law, anisotropy and heterogeneity	
Unit-2	Governing Equations for Groundwater Flow: Dupuit- Forchheimer assumptions, general differential equations governing groundwater flows, analytical solutions.	



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Unit-3	Wells and Well Hydraulics: Types of wells, construction of wells, steady and unsteady state solutions for confined, unconfined and leaky aquifers, effect of boundaries, image well theory, interference of wells, well losses, pumping and recovery test analysis.	
Unit-4	Groundwater Conservation: Regional groundwater budget; resource assessment; estimation of recharge, Indian practice for artificial recharge, Groundwater Quality: Contamination of groundwater, sources, remedial and preventive measures, seawater intrusion in coastal aquifers.	
Unit-5	Groundwater Flow Modeling: Role of groundwater flow models, Hele-Shaw and analog models, introduction to numerical modeling – boundary conditions, Planning of Groundwater Development: constraints, optimal groundwater development	

Textbooks:

- Groundwater Hydrology by Todd and Mays
- Groundwater Hydrology by H M Raghunath
- Introduction to Groundwater by Schwartz and Hubao Zhang
- Handbook of Groundwater by Jacques Delluer
- Groundwater Assessment, Development and Management by K R Karant



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I Year - II Semester	Program Core 6	L	T	P	C
		3	1	0	4
Irrigation Water Management					

Course Outcomes: At the end of the course, the student will be able to

CO1	Get an interest on irrigation by knowing the history and going through success stories
CO2	Get to know the state-of-the-art technologies in irrigation for sustainable management
CO3	Understand soil-water-crop relations, and the associated processes
CO4	Explore various lab and field scale instrumentation and measurement techniques in irrigation
CO5	Understand the performance of various crop simulation models and their application

Syllabus:

Unit	Contents	Contact Hours
Unit-1	History and development of irrigation in India; Irrigation projects – types, benefits, and challenges; Irrigation methods – drip and sprinkler methods; Irrigation structures – Design principles; Case studies of successful irrigation strategies	
Unit-2	Sustainable irrigation; Smart irrigation; Precision irrigation; Water and energy efficient irrigation methods; Hydroponics; Aeroponics; Vertical farming; Decision support system (DSS) for irrigation and agriculture	
Unit-3	Soil-water interactions – characteristic curves, field capacity, wilting point; Soil moisture – estimation methods; Evapotranspiration–estimation methods; Irrigation schedules; Irrigation efficiencies; Water-Crop interactions – root water uptake; plant water stress; Water use efficiency.	
Unit-4	Instrumentation for: rainfall, soil moisture, evaporation, evapotranspiration, meteorological variables, plant canopy, root water uptake – Design principles, Working methodology, advantages and limitations	
Unit-5	Design philosophy, working methodology, data requirement, and applications of: simualk, Aquacrop, SWAP, DSSAT.	



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Textbooks / References

- 1) Irrigation and Drainage Engineering by Peter Waller and Muluneh Yitayes, Springer
- 2) Irrigation Water Management by Dilp Kumar Majumdar, PHI Learning
- 3) Michael, A.M. 2006. Irrigation: Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi.



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I Year - II Semester	Program Elective 4	L	T	P	C
		3	1	0	3
(a) APPLICATIONS OF REMOTE SENSING & GIS IN WATER RESOURCES and ENVIRONMENTAL ENGINEERING					

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply basic principles of remote sensing for resource mapping and evaluation
CO2	Develop geospatial data base of water resources and environmental engineering systems
CO3	Apply GIS models for hydrological simulation
CO4	Apply GIS models for planning environmental engineering systems

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	3	2	
CO2	1		2	3	2	
CO3	2		3	2	3	
CO4	1		3	2	3	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Electromagnetic Spectrum - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing, Fundamentals of Microwave Remote Sensing	
Unit-2	Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections – Basic Pattern Recognition Concepts, Basic Principles of Visual Interpretation	



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Unit-3	Introduction to Standard Packages like ArcView, ArcGIS, AutoCAD Map, Map Info etc.	
Unit-4	Spatial Analysis and Modelling – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Spatial Auto Correlation, Gravity Modelling, DTM/DEM, Integration with Remote Sensing data Surface-Water Hydrologic Data, Spatial techniques for Surface-Water Hydrology Modeling, Surface-Water Hydrology Models, SWAT model and its applications	
Unit-5	Groundwater Data, Ground water Models and spatial techniques for Groundwater Modeling and Visualization, The Arc Hydro Data Model. Geospatial techniques for planning and design of Water-Supply and Irrigation Systems, Spatial Database Development for Wastewater and Storm water Systems, Geospatial technologies for Water Resources Monitoring and Forecasting; Spatial Decision-Support Systems in River Basin Management; Spatial systems for floodplain mapping and management, GIS for Water-Quality Management Decision Support	

Textbooks:

1. Textbook on Remote Sensing in Natural Resources Monitoring and Management, Agarwal, C. S., and Garg, P. K., Wheeler Publishing, Allahabad, 2000
2. Remote Sensing and Image Interpretation, Lillesand, T. M., and Keifer, R. W., John Wiley & Sons, N York, 1994

Reference Books:

1. Introduction to the Use of Geographical Information Systems for Practical Hydrology, Meijerink M. J., de Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., ITC publication no. 23, UNESCO, Paris, 1994
2. Remote Sensing – The Quantitative Approach, Swain, P. H., and Davis, S. M., mcgraw-Hill Pub. Co. N York, 1987

Online Resources:

1. <https://nptel.ac.in/courses/105/103/105103193/>
[Http://civil.iisc.ernet.in/~nagesh/rs_gis.htm](http://civil.iisc.ernet.in/~nagesh/rs_gis.htm)



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I Year - II Semester		L	T	P	C
	Program Elective 3	3	1	0	3
(b)DESIGN OF WATER SUPPLY AND SEWERAGE SYSTEMS					

Course Outcomes: At the end of the course the student will be able to:

CO1	Comprehend the need of Water supply and sewage systems
CO2	Design of water transmission and optimization of water distribution networks
CO3	Interpret the processes involved in secondary wastewater treatment systems.
CO4	Assimilate the Principles of sludge treatment and disposal methods.

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	1	2	-
CO2	2		2	1	3	-
CO3	2		2	1	3	1
CO4	2		2	1	3	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Sources of water and water quality- Planning of water supply systems, Selection of water treatment trains, Transportation of water; Appurtenances for water transmission; Selection of pipe materials, Jointing, Laying and Maintenance	
Unit-2	Water distribution pipe networks- Design, analysis and optimization, Water hammer analysis; –Corrosion prevention – Minimization of water losses – Leak detection- SCADA systems- Specific contaminant removal systems.	
Unit-3	Wastewater Sources and flow rates, Collection, Characteristics, Standards of Disposal, Treatment Objective and Strategies,	
Unit-4	Sewage collection systems; Sanitary sewer design, Biological Treatment Processes: Types, low-cost sanitation systems; Treated wastewater reuse/recycle	



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Unit-5	Water treatment residuals and Wastewater sludge management and disposal. Use of computer software in water transmission, water distribution, wastewater collection. Planning and Design Criteria ,Demand Estimation, Cost estimates, scheduling, CPHEEO guidelines, Funding guidelines, Regulatory framework, Construction methods: alternate design methods.	
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Learning Resources:

Textbooks:

1. Water and Wastewater Engineering: Design Principles and Practice, Mackenzie L. Davis, mcgraw Hill, 2010.
2. *Wastewater Engineering – Collection, Treatment, Disposal and Reuse*, Metcalf and Eddy, 5th Ed., McGraw Hill Pub. Co., 2014
3. Environmental Engineering, Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, McGraw Hill., 2017

Reference Books:

1. Water Supply and Wastewater Removal, Nazih K. Shamas, Lawrence K. Wang, 3rd Edition, John Wiley & Sons, Inc, 2011
2. WATER QUALITY& TREATMENT, AWWA Handbook, mcgraw Hill, 2011.
3. Urban Water Supply Handbook, Larry W. Mays, mcgraw Hill, 2002.
4. CPHEEO, Manual on Water Supply and Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, May 1999.
5. CPHEEO, Manual on Operation and Maintenance of Water Supply Systems, Ministry of Urban Development, New Delhi, January 2005.
6. CPHEEO, Manual on Sewerage and Sewage Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, November 2013.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ce23/preview
2. https://ocw.mit.edu/courses/urban-studies-and-planning/11-479j-water-and-sanitationinfrastructure-in-developing-countries-spring-2007/readings/hwts_paper.pdf
3. http://www.who.int/water_sanitation_health/dwq/WSH02.07.pdf
4. <https://nptel.ac.in/courses/105/105/105105178/>
5. <https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-85-water-andwastewater-treatment-engineering-spring-2006/lecture-notes/>
6. https://onlinecourses.nptel.ac.in/noc21_ce25/preview



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I Year - II Semester	Program Elective 3	L	T	P	C
		3	1	0	3
(c) COASTAL AND OCEAN ENGINEERING					

Course Outcomes: At the end of the course, the student will be able to

CO1	Basic concept of sediment transport and its principles of movement
CO2	Demonstrate the role of coastal sediment process and sediment transport models
CO3	Identify the Beach nourishment and its features
CO4	Identification of the problems of coastal protection and its prevention measures
CO5	Design principles of Coastal and Harbor structures

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	-	3	3	-	2
CO2	-	3	3	-	2
CO3	-	2	3	-	3
CO4	-	3	3	-	3
CO5	-	3	3	-	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	COASTAL ZONE PROCESS: General, Sediment properties; measurement and sampling techniques - fundamental principles of movement - bed load and suspended load transport	
Unit-2	Role of coastal sedimentation process - long shore drift - Beach Evaluation Models – General sediment transport models - On-shore and off-shore sediment transport.	
Unit-3	Beach nourishment - Coast and Bed Morphology - Regime of the Coast and Sea Beach – Sand features - Features of Estuaries - Coastal and Beach features	



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Unit-4	COASTAL PROTECTION: Identification of the problem - Restoration of the Beach - Groynes and Revetments - Off-shore Breakwaters, Bays and Artificial Headlands - Beach replenishment.	
Unit-5	DESIGN PRINCIPLES OF COASTAL AND HARBOUR STRUCTURES: Break water - types - Waves, Jetties and Piers; Docks - different types	

REFERENCES:

1. "Coastal Hydraulics" (2nd End) By A.M. Muir Wood and CA Fleming, John Wiley and Sons (Network).
2. "Coastal Engineering" (Vol. 1 & 2) by Richard L. Silvester, Elsevier Scientific Publishing Company.



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I Year - II Semester	Program Elective 3	L	T	P	C
		3	1	0	
(d) FREE SURFACE FLOW					

Course Outcomes: At the end of the course, the student will be able to

CO1	Compute flow profiles in channel transitions and due to hydraulic structures
CO2	Design channels including irrigation canals and storm water drains
CO3	Formulate and solve the problem of propagation of flood wave and surges in channels
CO4	Formulate and solve hydraulic flood routing models

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2		
CO2	1		2		3	1
CO3	2		3		2	2
CO4	2		3		2	2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Uniform Flow in Open Channels& Compound Channels, Specific energy, Critical flow, Channel transitions, Uniform flow formulae, best hydraulic sections.	
Unit-2	Steady Gradually Varied Flow, Non-uniform flow in open channels, gradually varied flow equations, Type of GVF profiles, Computation of GVF profiles	
Unit-3	Steady Rapidly Varied Flow, Hydraulic jump in a horizontal rectangular channel, Specific force, Computation of energy loss	
Unit-4	Unsteady Flow, Celerity of a gravity wave, Monoclonal rising wave, Positive and negative surges, St. Venant's equations, Method of characteristics,	
Unit-5	Hydraulic routing.	



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Textbooks:

1. Open Channel Hydraulics, Chow, V.T., mcgraw Hill Inc. N York, 1979
2. Open Channel Hydraulics, French, R.H., mcgraw Hill Pub Co., N York, 1986

Reference Books:

1. Flow in Open Channels, Subramanya, K., Tata mcgraw Hill Pub., 2008
2. Open Channel Hydraulics, Terry Sturm, Tata mcgraw Hill Pub., 2011

Online Resources:

1. <https://nptel.ac.in/courses/105/106/105106114/>



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I Year - II Semester	Program Elective 4	L	T	P	C
		3	1	0	3
(a) FLUVIAL HYDRAULICS					

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify the characteristics and properties of sediments
CO2	Comprehend the concept of incipient motion
CO3	Analyze and compute the bed load and suspended load
CO4	Design guide bunds and other river training banks

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	3		
CO2	1		2	3		
CO3	1		3	3	1	
CO4	1		3	1	3	1

Syllabus:

Unit	Contents	Contact Hours
Unit-1	The sediment problems, significant sediment properties, properties of sediment mixture, properties of fluid and suspended sediment mixture, terminal fall velocity of sediment in fluid, beginning of sediment movement – Shields analysis, incipient motion of uniform and nonuniform sediments, critical tractive stress of non-uniform materials.	
Unit-2	Bed Forms and Resistance: Bed load and suspended load transport for uniform and nonuniform bed material, various approaches for bed load transport, suspended load profile and suspended load equations, total load equations, sediment sampling, discharge concept for bed-load transport, sediment pickup function, sediment sorting and streambed armoring, total-load transport	
Unit-3	Stable channel design and sediment control, regime of flow, effective bed roughness, no scouring erodible –boundary channels.	



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Unit-4	Bed level variations, degradation, aggradation, local scour, scour within channel contractions, scour downstream of structures, scour below horizontal pipelines, scour at bridge piers and abutments, scour counter measures, reservoir sedimentation and its monitoring.	
Unit-5	Physical and mathematical models, dimensional analysis, concept of dynamic similitude for model studies, immobile bed model studies, mobile bed model studies, design of guide bunds and other river training banks.	

Learning Resources:

Textbooks:

1. Fluvial Hydraulics, Dey, S., Springer, 2014.
2. Mechanics of Sediment Transportation and Alluvial Stream Problems, Garde, R. J. And Ranga Raju, K. G., New Age Publishers, 2007.
3. Principals of River Engineering, Jansen, P.P.H., VSSD Publications, 1996.
4. River Morphology, Garde, R.J., New International Publishers, 2006
5. Erosion and Sedimentation, Julien, P.Y., Cambridge University Press, 1998.

Reference Book:

1. Scouring: hydraulic structures design manual series, vol. 2, Breusers, H. N. C., & Raudkivi, A. J., CRC Press, 2020.
2. Principles of River Hydraulics, Aronne Armanini, Springer International Publishing, 2018.
3. River Hydraulics, U. S. Army Corps of Engineers, University Press of the Pacific, 2004.

Online Resources:

1. <https://www.routledge.com/IAHR-Design-Manual/book-series/TFIAHRHSDM>



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I Year - II Semester	Program Elective 4	L	T	P	C
		3	1	0	3
(b)HYDROPOWER SYSTEMS					

Course Outcomes: At the end of the course, the student will be able to

CO1	Estimate hydropower potential
CO2	Identify types of hydropower plants
CO3	Design penstocks and surge shaft
CO4	Plan the layout of a hydropower plant
CO5	Analyze water hammer and surges

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2	2	
CO2	1		2	2	3	
CO3	2		3	1	3	
CO4	1		3	3		2

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Introduction to Hydropower Systems: sources of energy, role of hydropower in a power system. Estimation of Hydropower Potential: Flow duration curves of gauge and ungauged streams, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load.	
Unit-2	Planning and layout of Hydropower Plants: types of Hydropower Plants: Runoff River plants, general arrangement of runoff river plants, valley dam plants, diversion canal plants, high head diversion plants, storage and pondage, pumped storage power plants, micro power plants. Penstocks: Classification of penstocks, economical design of penstocks, losses, anchor blocks, valves, bends and manifolds. Trash racks: Types, losses, design, stability.	



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Unit-3	Intakes: Types, losses, air entrainment, anti-vortex device, air vent, power channels, forebay, tunnel. Turbines: Introduction, types of turbines, hydraulics of turbines, draft tubes, cavitation in turbines, turbine model testing, characteristics of turbines, selection of turbine	
Unit-4	Water Hammer and Surges: Introduction, water hammer, transients caused by turbine, load acceptance and rejection, resonance in penstocks, channel surges.	
Unit-5	Surge Tanks: Functions, types of surge tanks, differential surge tanks, design of surge tanks- Calame-Gaden equations, Johnson's method, stability of surge tanks.	

Learning Resources:

Textbooks:

1. Waterpower Engineering, Dandekar, M.M., and Sharma, K.H., Vikas Publishing House Pvt. Ltd. 2000.
2. Waterpower Engineering, Barrows, H.K., Tata mcgraw Hill Publishing Company Ltd. 1943.
3. Hydro Power Structures, Varshney, R.S., Nem Chand & Bros. 2001.

Reference Books:

1. Hydro Electric Engineering, Nigam, P.S., Nem Chand & Bros. 2001.
2. Applied Hydraulic Transients, Choudhary, M.H., Van Nostrand Reinhold Company 1987.
3. Fluid Transients, Streeter, V.L., and Wylie, B., mcgraw-Hill Book Company. 1967.
4. Hydropower Engineering, Warnick, C.C., Prentice-Hall. 1984.
5. Norwegian Institute of Technology: Hydropower Development: Vols. 3, 4, 5 & 6, Division of Hydraulic Engineering. 1992-93.

Online Resources:

1. <https://www.energy.gov/eere/water/hydropower-resource-assessment-andcharacterization>
2. <https://www.hydropower.org/iha/discover-types-of-hydropower>



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I Year - II Semester	Program Elective 4	L	T	P	C
		3	1	0	3
(c) ENVIRONMENTAL HYDROLOGY AND HYDRAULICS					

Unit	Contents	Contact Hours
Unit-1	Introduction - Statistical analysis of Hydrological Data - Rainfall and Runoff estimation, Intensity-s—Duration frequency Curves, Drain storage with different risks-	
Unit-2	Hydraulics of ground water flow - Non—equilibrium flow, Yield estimations, Interferences - Infiltration galleries, ground water recharge- principles of water shed management	
Unit-3	Transportation of water - Storage capacity, Pumping of water, Design and selection of economical diameter of pump main — open channel now — of open channel now sections	
Unit-4	Distribution of Water - Pressure and capacity requirements Of distribution system, Analysis Of networks, Appurtenances in a distribution Layout, detection and prevention Of leakage mains	
Unit-5	Hydraulics of Sewers - Sewers and its appurtenances - Design of sewers in hill and partial flow conditions, Flow at Sewer transitions, Sewage pumping.	

Reference Books:

1. Water and Wastewater Engineering by Fair, Gayer and Okun
 2. CPHEEO Manual on water supply & treatment
- CPHEEO Manual on Sewage & Sewerage Systems



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I Year -I I Semester	Program Elective 4	L	T	P	C
		3	1	0	3
(d)Water Supply Systems					

Pre-Requisites: None Course Outcomes:

CO1	Plan water supply systems for a community
CO2	Analyze water quality and propose water treatment train
CO3	Design various components of a water treatment plant
CO4	Design advanced treatment systems for the removal of specific contaminants
CO5	Analyze and design water distribution systems
CO6	Plan an appropriate water reuse system

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	1
CO2	3	2	2	3	1	-
CO3	3	2	3	1	3	1
CO4	3	2	3	1	3	1
CO5	3	2	2	3	1	-
CO6	3	2	1	1	2	1

Syllabus:

Unit	Contents	Contact Hours
Unit-1	Need for Transport of water- Water quality- Planning of water supply systems	
Unit-2	Intake structures , Selection of pipe materials, Water transmission main design- Gravity and pumping main; Selection of Pumps- Characteristics-Economics; Jointing, Laying and Maintenance, Water hammer analysis; Water distribution pipe networks- Design, analysis and optimization –Appurtenances –Corrosion prevention – Minimization of water losses – Leak detection- SCADA systems- Storage reservoirs	



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Unit-3	Water treatment: Screening – Mixing- Equalization – Sedimentation – Coagulation, Flocculation- Filtration– Back washing –Membrane separation- Reverse Osmosis- Nano filtration, Ultra Filtration-Electro dialysis- -Specific contaminant removal systems- Disinfection- Distribution	
Unit-4	Water reuse/recycle- Sludge Thickening-Sludge dewatering systems-Sludge drying beds- Recent Advances?? include. Direct potable reuse, IPR	
Unit-5	Use of computer software in water transmission and water distribution systems. Planning and Design Criteria, Demand Estimation, Cost estimates, scheduling, Rainwater harvesting, Industrial reuse, Data centers, CPHEEO guidelines, Funding guidelines, Regulatory framework, Construction methods: alternate design methods?	

Textbooks:

1. Mackenzie L. Davis, Water and Wastewater Engineering: Design Principles and Practice, mcgraw Hill, 2010.
2. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, mcgraw Hill., 2017

Reference Books:

1. Viessman Jr, Hammer J. M, Perez, E.M, and Chadik, P. A, Water Supply and Pollution Control, PHI Learning, New Delhi, 2009
2. WATER QUALITY& TREATMENT AWWA Handbook, mcgraw Hill, 2011.
3. Larry W. Mays, Urban Water Supply Handbook, mcgraw Hill, 2002.
4. Computer modelling of water distribution system, AWWA manual of water supply practice, 2005.

Other Suggested Readings:

- 1 https://onlinecourses.nptel.ac.in/noc20_ce23/preview
- 2 https://ocw.mit.edu/courses/urban-studies-and-planning/11-479j-water-and-sanitationinfrastructure-in-developing-countries-spring-2007/readings/hwts_paper.pdf
- 3 [Http://www.who.int/water_sanitation_health/dwq/WSH02.07.pdf](http://www.who.int/water_sanitation_health/dwq/WSH02.07.pdf)



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I Year - II Semester	Laboratory 3	L	T	P	C
		0	1	2	2
HYDROLOGIC AND HYDRAULIC MODELLING LAB					

Course Outcomes: At the end of the course, the student will be able to

CO1	Compare and comprehend different hydrologic and hydraulic models
CO2	Utilize hydrological models such as SWAT and HEC-HMS for hydrological analysis
CO3	Make use of hydraulic models for analysis of water distribution and drainage networks
CO4	Apply hydrologic and hydraulic models for design of urban water systems

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	1	
CO2	2	1	3	2		1
CO3	2	1	3	2	1	1
CO4	2	1	3		3	2

Syllabus:

Unit	Contents	Contact Hours
	Design and analysis of water distribution networks using EPANET; Downloading and using data from various open sources, Event based flood modelling using HEC-HMS, Continuous simulation modelling using SWAT; Flood inundation mapping using HEC-RAS; Design and analysis of storm water drainage network using SWMM Learning Resources	

: Reference Books:

1. HEC-HMS: Hydrologic Engineering Centre's- Hydrologic Modelling System <http://www.hec.usace.army.mil/software/hec-hms/>
2. HEC-RAS: Hydrologic Engineering centers River Analysis System <http://www.hec.usace.army.mil/software/hec-ras/>
3. SWMM: Storm Water Management Model <http://www2.epa.gov/water-research/stormwater-management-model-swmm>
4. SWAT: Soil and Water Assessment Tool <http://swat.tamu.edu/>
5. EPANET: Hydraulic modelling of water distribution piping system <http://www2.epa.gov/water-research/epanet> Online Resources:



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I Year - II Semester	Laboratory 4	L	T	P	C
		1	1	2	2
WATER RESOURCES SYSTEMS DESIGN LABORATORY					

Course Outcomes: At the end of the course, the student will be able to

CO1	Develop storage-yield-reliability relationship for a reservoir & optimal operating policy of a reservoir
CO2	Simulate and evaluate the performance of a reservoir
CO3	Plan and develop an irrigation system
CO4	Develop optimal policy for water quality management in a river

CO-PO mapping:

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	2	3	1
CO2	1	1	2	2	2	1
CO3	2	2	3	1	3	1
CO4	2	2	3	1	3	2

Syllabus:

Unit	Contents	Contact Hours
	<p>Determining storage capacity of a reservoir, Development of storage-yield-reliability relationship for a reservoir, Developing optimal operating policy for a single and Mult reservoir system</p> <p>Crop planning and irrigation scheduling, Water quality management in a river</p> <p>Optimal design of water distribution networks, Simulation of operation of a reservoir,</p> <p>Simulation of an aquifer, Performance evaluation of an irrigation system</p> <p>Demonstration of the applications of Genetic algorithm and other evolutionary algorithms.</p>	



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Learning Resources:

Textbooks:

1. Water Resources Systems Planning and Management – An introduction to methods, models and applications, Studies and Reports in Hydrology, Loucks, D. P., and Eelco van Beek UNESCO Publishing, 2005
2. Civil and Environmental Systems Engineering, Revelle, S.C., Whitlatch, E. E., and Wright, R. J., Pearson Education Inc., New Jersey, 2004

Reference Books:

1. Water Resources Systems Modeling Techniques and Analysis, Vedula, S., and Mujumdar, P.P., Tata McGraw Hill Pub. Co., New Delhi, 2005
2. Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications, Daniel P. Loucks and Eelco van Beek, Springer International Publishing, 2018

Online Resources:

1. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/irrigationscheduling>