K.S.R.M.
COLLEGE OF ENGINEERING

(UGC - Autonomous)
Accredited by NAAC with A+ Grade & B.Tech. (EEE, ECE, CSE, CE and ME) Programs by NBA
An ISO 9001:2015, 14001: 2015 & 50001: 2018 Certified Institution

ACADEMIC REGULATIONS (R25PG)
COURSE STRUCTURE AND SYLLABI

(Effective for the students admitted into I year
from the academic year 2025 -2026 onwards)

MASTER OF TECHNOLOGY (M.Tech.)
GEOTECHNICAL ENGINEERING
(Regular, Full-time)

VISION AND MISSION
OF
K.S.R.M. COLLEGE OF ENGINEERING

VISION:

To evolve as a centre of repute for providing quality academic programs amalgamated with creative learning and research excellence to produce graduates with leadership qualities, ethical and human values to serve the nation.

MISSION:

M1. Provide high quality education with enriched curriculum blended with impactful Teaching-Learning practices.

M2. Promote Research, Entrepreneurship and Innovation through industry collaborations.

M3. Produce highly competent professional leaders for contributing to socio-economic development of the region and the nation.

VISION AND MISSION
OF
DEPARTMENT OF CIVIL ENGINEERING

VISION

To be a leading center for Civil Engineering education and research focusing on producing Industry-ready, skilled and ethical professionals with leadership qualities embedded with human values to serve society and the nation.

MISSION

M1. Providing quality Civil Engineering education with a modern, outcome based curriculum and effective teaching-learning methods following Professional Ethics.

M2. Using modern tools and techniques to do research, consultancy and upskilling through collaboration with industries thereby providing sustainable engineering solutions for society and the country.

M3. Developing leadership qualities, entrepreneurship, and moral values in students for the development of nation.

M.Tech. GEOTECHNICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. To promote highly skilled geotechnical engineers who excel in designing and executing innovative projects within advanced geotechnical engineering and infrastructure domains.

PEO2. To foster passionate researchers and lifelong learners, equipped for dynamic professional advancement and cutting-edge exploration in geotechnical engineering.

PEO3. To nurture visionary leaders and responsible innovators, committed to sustainable construction and pioneering ground improvement solutions that address global challenges with integrity.

PEO4. To empower graduates to communicate effectively, demonstrate exemplary leadership, and uphold ethical standards while responding to complex societal and environmental challenges in geotechnical engineering practice.

PROGRAM OUTCOMES (POs)

After successful completion of the program, graduates will be able to

PO1. Apply advanced principles of soil mechanics, rock mechanics, and geotechnical analysis to evaluate and solve complex soil related engineering problems.

PO2. Plan and execute geotechnical investigations, interpret field and laboratory data accurately and conduct research to address challenges in soil behaviour, foundation performance and ground stability.

PO3. Design sustainable geotechnical systems including foundations, retaining structures, slopes, embankments and ground improvement solutions in line with Professional standards.

PO4. Use advanced geotechnical software, numerical modelling tools, and project management practices to analyze, design, and implement geotechnical engineering projects effectively.

PO5. Communicate technical information effectively and uphold ethical standards in professional practice and decision-making.

PO6. Pursue lifelong learning and understand the social, environmental and global impact of geotechnical engineering solutions.

K.S.R.M. COLLEGE OF ENGINEERING

(AUTONOMOUS)

Academic Regulations of M.Tech. (Full Time/Regular) Programme

(Effective for the students admitted into I year from the Academic Year 2025-26 and onwards)

K.S.R.M. College of Engineering (KSRMCE) offers **Two** Years (**Four** Semesters) full-time Master of Technology (M.Tech.) Degree programme, under Choice Based Credit System (CBCS) in different branches of Engineering and Technology with different specializations.

The affiliating university Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. degree on candidates who are admitted to the programme and fulfill all the requirements for the award of the degree.

1. Award of the M.Tech. Degree

A student will be declared eligible for the award of the M.Tech. degree if he/she fulfils the following:

1.1 Pursues a course of study for not less than two academic years and not more than four academic years.

1.2 Registers for 75 credits and secures all 75 credits.

2. Students, who fail to fulfil all the academic requirements for the award of the degree within four academic years from the year of their admission, shall forfeit their seat in M.Tech. course and their admission stands cancelled.

3. Programme of Study:

The following M.Tech. Specializations are offered at present in different branches of Engineering and Technology and are as follows:

Discipline	**Name of the Specialization**	**Code**
Civil Engineering	Geo Technical Engineering	12
Electrical and Electronics Engineering	Power Systems	52
Mechanical Engineering	Renewable Energy	99
Computer Science and Engineering	Artificial Intelligence and Data Science	98
Electronics & Communication Engineering	Embedded Systems & VLSI	84

4. Eligibility for Admissions:

4.1 Admission to the M. Tech Program shall be made subject to the eligibility, qualification and specialization prescribed by the A.P. State Government/University from time to time.

4.2 Admissions shall be made either on the basis of either the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by A.P. State Government (APPGECET) for M.Tech. programmes an entrance test conducted by University/on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

5. Programme related terms:

5.1 ***Credit:*** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (Lecture/Tutorial) or two hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

5.2 ***Academic Year:*** Two consecutive (one odd + one even) semesters constitute one academic year.

5.3 ***Choice Based Credit System (CBCS):*** The CBCS provides choice for students to select from the prescribed courses.

6. Programme Pattern:

6.1 Total duration of the of M.Tech. programme is two academic years

6.2 Each academic year of study is divided into two semesters.

6.3 Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional days per semester.

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

6.5 The medium of instruction of the programme (including examinations and project reports) will be in English only.

6.6 All subjects/courses offered for the M.Tech. degree programme are broadly classified as follows:

S. No.	Broad Course Classification	Course Category	Description
1.	Core Courses	Foundational & Professional Core Courses (PC)	Includes subjects related to the parent discipline / department / branch of Engineering/specialization.
2.	Elective Courses	Program Elective Courses (PE)	Includes elective courses related to the parent discipline / department / branch of Engineering
		Open Elective Courses (OE)	Elective courses which include inter-disciplinary courses or courses in an area outside the parent discipline which are of importance in the context of special skill development
3.	Mandatory Courses	Quantum Technology and Application	To understand importance of latest technologies, research and process of creation of patents through research
		Research methodology & IPR	
4.	Integrated Experiential Learning Courses	Skill Enhancement courses (SE)	Interdisciplinary / job-oriented / domain courses which are relevant to the industry
		Comprehensive Viva	To test the overall domain knowledge
		Short Term Industry Internship	To provide real time exposure
		Dissertation	To provide application of domain knowledge to solve real problems

S. No.	Broad Course Classification	Course Category	Description
5.	Audit Courses	Mandatory non-credit courses	Covering courses of developing desired attitude among the learners.

6.7 The college shall take measures to implement Virtual Labs (https://www.vlab.co.in) which provide remote access to labs in various disciplines of Engineering and will help student in learning basic and advanced concept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.

6.8 A faculty advisor/mentor shall be assigned to each specialization to advise students on the programme, its Course Structure and Curriculum, Choice of Courses, based on his competence, progress, pre-requisites and interest.

6.9 Preferably 25% course work for the theory courses in every semester shall be conducted in the blended mode of learning.

7. Attendance Requirements:

7.1 A student shall be eligible to appear for the Semester-End examinations if he/she acquires i) a minimum of 50% attendance in each course and ii) 75% of attendance in aggregate of all the courses.

7.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

7.3 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence

7.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their semester-end examination of that class.

7.5 A stipulated fee shall be payable towards condonation of shortage of attendance.

7.6 A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek re-admission into that semester when offered next.

7.7 If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

7.8 If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

8. Evaluation – Distribution and Weightage of Marks:

The performance of a student in each semester shall be evaluated course - wise (irrespective of credits assigned), for a maximum of 100 marks for theory and 100 marks for practical, based on Internal Evaluation and Semester-End Examination.

8.1 There shall be five units in each of the theory courses. For the theory courses 60 marks will be for the Semester-End Examination and 40 marks will be for Internal Evaluation.

8.2 Two Internal Examinations shall be conducted for 30 marks each, one in the middle of the Semester and the other immediately after the completion of instruction period. The other 10 marks is awarded for continuous assessment in the form of assignments, quizzes, open book examination, presentation, etc. First mid examination shall be conducted for I & II units of the syllabus and second mid examination for III, IV & V units. Each mid

exam shall be conducted for a total duration of 120 minutes with 3 questions (without choice) and each question carries 10 marks. Final Internal marks for a total of 40 marks shall be arrived at by considering the marks secured by the student in both the internal examinations with 80% weightage to the better internal exam and 20% to the other.

8.3 The following pattern shall be followed in the End Examination:

i. Five questions shall be set from each of the five units with either/or type for 12 marks each.
ii. All the questions have to be answered compulsorily.
iii. Each question may consist of one, two or more sub-questions.

8.4 For practical courses, 60 marks shall be for the Semester-End Examinations and 40 marks will be for internal evaluation based on the day-to-day performance.

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 semester-end examination shall be conducted by the examiners, with a breakup mark of Procedure-10, Experimentation-25, Results-10, Viva-Voce-15.

8.5 There shall be Mandatory **Audit courses** in I & II semesters for zero credits. There is no external examination for audit courses. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations. In case, the student fails, a re-examination shall be conducted for failed candidates for 40 marks for every six months/semester satisfying the conditions mentioned in item 1 & 2 of the regulations.

8.6 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 Semester-End Examination and a minimum aggregate of 50% of the total marks in the Semester-End Examination and Internal Evaluation taken together.

8.7 In case the candidate does not secure the minimum academic requirement in any of the courses he/she has to reappear for the Semester-End Examination either supplementary or regular in that course or repeat the course when next offered or do any other specified course as may be required.

8.8 The laboratory records and mid semester test papers shall be preserved for a minimum of 3 years in the respective institutions as per the University norms and shall be produced to the Committees of the University as and when the same are asked for.

9. Credit Transfer Policy

As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, students are allowed to do up to a maximum of 40% of the Professional and Open Electives in a semester through SWAYAM/SWAYAM Plus.

9.1 The college offers credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform.

9.2 The online learning courses available on the SWAYAM platform will be considered for credit transfer. SWAYAM course credits are as specified in the platform

9.3 Student registration for the MOOCs shall be only through the college, it is mandatory for the student to share necessary information with the college

9.4 The institution will list out the courses to be permitted for credit transfer through

SWAYAM. However, while selecting courses in the online platform institution would essentially avoid the courses offered through the curriculum in the offline mode.

9.5 The institution will notify at the beginning of semester the list of the online learning courses eligible for credit transfer in the forthcoming Semester.

9.6 Students may register for an 8-week (2 credits) or 12-week (3 credits) SWAYAM / SWAYAM plus course with the approval of the Head of the Department (HoD).

9.7 Examination fees, if applicable, shall be borne by the student. Pass marks and grading will be as per the JNTUA academic regulations.

9.8 A student must get minimum 40% marks for assignments and quizzes on the SWAYAM/ SWAYAM plus platform to be eligible for the semester-end examination. The students who are unable to get minimum internal marks in SWAYAM/ SWAYAM plus platform, they have to re-register for the course in subsequent semester through SWAYAM/ SWAYAM plus platform.

9.9 The semester-end exam may be conducted by the National Testing Agency (NTA), the National Programme on Technology Enhanced Learning (NPTEL) or the College during the regular term-end exams. Evaluation shall comprise 60% weightage for the semester-end examination and 40% for assignments and quizzes conducted by the SWAYAM/ SWAYAM plus course coordinator. The student has to get 50% marks for internal and external with minimum of 40% marks in the external examination to declare them as pass.

9.10 The institution also ensures that the student completes the course and produces the course completion certificate as per the academic schedule given for the regular courses in that semester. However, the credits will be transferred to the students who got minimum 50% marks with 40% marks in the external examination

9.11 The institution will designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.

9.12 The college will ensure no overlap of SWAYAM MOOC exams with that of the semester-end examination schedule. In case of delay in SWAYAM results, the college will re-issue the marks sheet for such students.

9.13 Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued by the competent authority along with the minimum 50% of marks and grades.

9.14 The institution maintains the following in the examination section and submits as and when demanded by the university:

a) List of students who have passed MOOC courses in the current semester along with the certificates of completion.
b) Undertaking form filled by the students for credit transfer.

9.15 The college will resolve any issues that may arise in the implementation of this policy from time to time and shall review its credit transfer policy in the light of periodic changes brought by UGC, SWAYAM, NPTEL and state government.

Note: Students are also be permitted to register for MOOCs offered through online platforms other than SWAYAM NPTEL. In such cases, credit transfer shall be permitted only after seeking approval of the Principal with the recommendations of the concerned HoD and Dean, Academics at least three months prior to the commencement of the semester.

10. Re-registration for Improvement of Internal Evaluation Marks:

A candidate shall be given one chance to re-register for each course provided the internal marks secured by a candidate are less than 50% and has failed in the end examination

10.1 The candidate should have completed the course work and obtained examinations results for **I, II and III** semesters.

10.2 The candidate should have passed all the courses for which the Internal Evaluation marks secured are more than 50%.

10.3 Out of the courses the candidate has failed in the examination due to Internal Evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory course and for a maximum of **three** Theory courses for Improvement of Internal evaluation marks.

10.4 The candidate has to re-register for the chosen courses and fulfill the academic requirements.

10.5 For re-registration, the candidates have to apply to the Principal through the respective HoD by paying the requisite fees and get approval from the Principal before the start of the semester in which re-registration is required

10.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the Semester-End Examinations marks secured in the previous attempt(s) for the reregistered courses stand cancelled.

11. Evaluation of Project/Dissertation Work:

The Project work shall be initiated at the beginning of the III-Semester and the duration of the Project is of two semesters. Evaluation of Project work is for 300 marks with 200 marks for internal evaluation and 100 marks for external evaluation. Progress of the project work is monitored through three reviews:

- Project review – I at the beginning of the III semester for zero marks
- Project review – II at the end of the third semester for 100 marks
- Project review – III before submission of the thesis i.e., end of the IV semesters for 100 marks

External evaluation of final Project work viva voce in IV semester shall be for 100 marks.

A Project Review Committee (PRC) shall be constituted with the Head of the Department as Chairperson, Project Supervisor and one faculty member of the department offering the M.Tech. programme.

11.1 A candidate is permitted to register for the Project Work in III Semester after satisfying the attendance requirements in all the courses, both theory and laboratory (in I & II semesters).

11.2 A candidate is permitted to submit Project dissertation with the approval of PRC. The candidate has to pass all the theory, practical and other courses before submission of the Thesis.

11.3 Project work shall be carried out under the supervision of teacher in the parent department concerned.

11.4 A candidate shall be permitted to work on the project in an industry/research organization on the recommendation of the Head of the Department. In such cases, one

of the teachers from the department concerned would be the internal guide and an expert from the industry/research organization concerned shall act as co-supervisor/external guide. It is mandatory for the candidate to make full disclosure of all data/results on which they wish to base their dissertation. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. A certificate from the external supervisor is to be included in the dissertation.

11.5 Continuous assessment of Project Work - I and Project Work – II in III & IV semesters respectively will be monitored by the PRC.

11.6 The candidate shall submit status report by giving seminars in three different phases (two in III semester and one in IV semester) during the project work period. These seminar reports must be approved by the PRC before submission of the Project Thesis.

11.7 After registration, a candidate must present in Project Review - I, in consultation with his Project Supervisor, the title, objective and plan of action of his Project work to the PRC for approval within four weeks from the commencement of III Semester. Student shall initiate the project work, only after obtaining the approval of the PRC.

11.8 The Project Review - II in III semester carries internal marks of 100. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Project Work.

11.9 A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - II. Only after successful completion of Project Review – II, candidate shall be permitted for Project Work Review – III in IV Semester. The unsuccessful students in Project Review - II shall reappear after three months.

11.10 The Project Review - III in IV semester carries 100 internal marks. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The PRC will examine the overall progress of the Project Work and decide whether or not eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - III. If student fails to obtain the required minimum marks, he/she has to reappear for Project Review - III after a month.

11.11 For the approval of PRC, the candidate shall submit the draft copy of dissertation to the Head of the Department and make an oral presentation before the PRC.

11.12 After approval from the PRC, the student is permitted to submit a report. The dissertation report will be accepted only when the plagiarism is within 30% checked through Turnitin software (repository mode). The plagiarism report shall be submitted along with the dissertation report.

11.13 Research paper related to the Project Work shall be published in an SCI / SCIE / ESCI / Scopus or in conference proceedings with ISBN number organized by professional societies such as IEEE, IEI, etc.

11.14 After successful plagiarism check and publication of research paper, three copies of the dissertation certified by the supervisor and HOD shall be submitted to the College.

11.15 The dissertation shall be adjudicated by an external examiner selected by the College. For this, a panel of three examiners shall be submitted by the supervisor concerned and department head for each student. However, the dissertation will be adjudicated by one examiner nominated by the Principal.

11.16 If the report of the examiner is not satisfactory, the candidate shall revise and resubmit the dissertation, in the time frame as decided by the PRC. If report of the examiner is unfavorable 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 Principal.

11.17 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Project Viva voce exam.

11.18 The Project Viva voce examinations shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who has adjudicated the dissertation. For Dissertation Evaluation (Viva voce) in IV Sem. there are external marks of 100 and it is evaluated by external examiner. The candidate has to secure a minimum of 50% marks in Viva voce exam.

11.19 If he fails to fulfill the requirements as specified, he will reappear for the Project Viva voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree.

12 Industry Internships:

Industry internship either onsite or virtual with a minimum of 06-08 weeks duration, done at the end of 1st year second semester. It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Power projects, software MNCs or any industries in the areas of concerned specialization of the PG program. The student shall register for the internship as per course structure after commencement of academic year.

Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, Mentor/Supervisor of the internship and a senior faculty member of the department. A certificate of successful completion from industry shall be included in the report. Internship will be evaluated for 100 marks with 50 marks for the report evaluated by the mentor and 50 marks for oral presentation. A student should secure minimum 50% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the College.

13 Comprehensive Viva

A Comprehensive Viva shall be conducted after the II Semester examinations for 100 marks by a committee consisting of the Head of the Department, one senior faculty member of the same specialization, and an external subject expert appointed by the Principal. The student must secure a minimum of 50% marks to be declared as passed

14 Credits for Co-curricular Activities

A Student should earn 01 credits under the head of co-curricular activities, viz., attending Conference, Scientific Presentations and Other Scholarly Activities. The guidelines for awarding Credits for Co-curricular Activities are detailed in the following Table.

Name of the Activity	Maximum Credits / Activity
Participation in National Level Seminar / Conference / Workshop / Training programs (related to the specialization of the student)	0.5
Participation in International Level Seminar / Conference / Workshop / Training programs held outside India (related to the specialization of the student)	1
Academic Award/Research Award from State Level / National Agencies	0.5
Academic Award / Research Award from International Agencies	1
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	0.5
Research / Review Publication in International Journals with Editorial board outside India (Indexed in Scopus / Web of Science)	1

Note:

i) Credit shall be awarded only for the first author. Certificate of attendance and participation in a Conference/Seminar is to be submitted for awarding credit. A minimum participation of five days is required to earn the necessary credits. Alternatively, the student may attend five different one day programs to meet this requirement.

ii) Certificate of attendance and participation in workshops and training programs (Internal or External) is to be submitted for awarding credit. The total duration should be at least one week.

iii) Participation in any activity shall be permitted only once for acquiring required credits under cocurricular activities

15 Grading:

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

After each course is evaluated for 100 marks, the marks obtained in each course will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Range in which the marks in the course fall	Grade	Grade points Assigned
≥ 90	S (Superior)	10
≥ 80 < 90	A (Excellent)	9
≥ 70 < 80	B (Very Good)	8
≥ 60 < 70	C (Good)	7
≥ 50 < 60	D (Pass)	6
< 50	F (Fail)	0
Absent	Ab (Absent)	0

i) A student obtaining Grade "F" or Grade "Ab" in a course shall be considered failed and will be required to reappear for that course when it is offered the next supplementary examination.

ii) For noncredit audit courses, "Satisfactory" or "Unsatisfactory" shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA / CGPA / Percentage.

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The Semester Grade Point Average (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.,

$SGPA = \Sigma (C_i \times G_i)/\Sigma C_i$

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.

i) The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,
   $CGPA = \Sigma (C_j \times S_i)/ \Sigma C_j$
   where "S_i" is the SGPA of the i^{th} semester and C_j is the total number of credits up to that semester.
ii) Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
iii) While computing the SGPA the courses in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters S, A, B, C, D and F.

16 Award of 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 three classes:

Class Awarded	CGPA to be secured
First Class with Distinction	≥7.5%
First Class	< 7.5≥ 6.5
Pass Class	< 6.5

17 Exit Policy:

The student shall be permitted to exit with a PG Diploma based on his/her request to the university through the respective institution at the end of first year subject to passing all the courses in first year.

The Academic Council shall resolve any issues that may arise in the implementation of this policy from time to time and shall review the policy in the light of periodic changes brought by UGC, AICTE and State government.

18 Withholding of Results:

If the candidate has any case of in-discipline pending against him/her, the result of the candidate shall be withheld, and he/she will not be allowed/promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

19 Transitory Regulations

Discontinued, detained, or failed candidates are eligible for readmission as and when the semester is offered after fulfilment of academic regulations. Candidates who have been detained for want of attendance or not fulfilled academic requirements or who have failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent courses as and when courses are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

20 General:

20.1 The academic regulations should be read as a whole for purpose of any interpretation.

20.2 Disciplinary action for Malpractice / improper conduct in examinations is appended.

20.3 There shall be no places transfer within the constituent colleges and affiliated colleges of Jawaharlal Nehru Technological University Anantapur.

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

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

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

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RULES FOR

DISCIPLINARY ACTION FOR MALPRACTICES / IMPROPER CONDUCT IN EXAMINATIONS

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course 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 course of the examination).	Expulsion from the examination hall and cancellation of the performance in that course only.
1.(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell 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 course 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 course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses 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 for four 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. The performance of the original candidate who has been impersonated, shall be cancelled in all the courses of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester/year. The candidate is also debarred for four consecutive semesters from class work and all University examinations if his

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
		involvement is established. Otherwise, the candidate is 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 course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course only.
6.	Refuses to obey the orders of the Chief Superintendent /Assistant - Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the 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	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that semester / year. If the candidate physically assaults the invigilator / officer-in-charge of the Examinations, then the candidate is also debarred and forfeits his/her seat. In case of outsiders, they will be handed over to the police and a police case is registered against them.

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
	of the examination.	
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester / year. The candidate is also debarred and forfeits the seat. Person (s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course only or in that course and all other courses the candidate has appeared including practical examinations and project work of that semester / year

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
		examinations, depending on the recommendation of the committee.
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.	

1. Malpractices identified by squad or special invigilators
2. Punishments to the candidates as per the above guidelines.
3. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
4. A show cause notice shall be issued to the college.
5. Impose a suitable fine on the college.
6. Shifting the examination center from the college to another college for a specific period of not less than one year.

Note:

Whenever the performance of a student is cancelled in any course/courses due to Malpractice, he has to register for End Examinations in that course/courses consequently and has to fulfil all the norms required for the award of Degree.

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COURSE STRUCTURE

M.Tech. GEOTECHNICAL ENGINEERING

I-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2512101	Advanced Soil Mechanics	PC	3	0	0	3
2.	2512102	Sub surface Investigations and Instrumentation	PC	3	0	0	3
3.	**Program Elective-I**		PE	3	0	0	3
	2512103	Engineering Rock Mechanics					
	2512104	Critical Soil Mechanics					
	2512105	Environmental Geotechnology					
4.	**Program Elective-II**		PE	3	0	0	3
	2512106	Finite Element Methods in Geo mechanics					
	2512107	Computational Geomechanics					
	2512108	Soil Structure Interaction					
5.	2512151	Soil Mechanics – I Lab	PC	0	0	4	2
6.	2512152	Soil Mechanics –II Lab	PC	0	0	4	2
7.	2512153	GeoStudio	SE	0	1	2	2
8.	2599171	Research Methodology and Intellectual Property Rights	MC	2	0	0	2
9.	**Audit Course–I**		AC	2	0	0	0
	2599181	English for Research Paper Writing					
	2512181	Disaster Management					
	2598181	Essence of Indian Traditional Knowledge					
			TOTAL	**16**	**1**	**10**	**20**

II-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2512201	Advanced Foundation Engineering	PC	3	0	0	3
2.	2512202	Ground Improvement Techniques	PC	3	0	0	3
3.	**Program Elective-III**		PE	3	0	0	3
	2512203	Earth Retaining Structures					
	2512204	Design of Underground Excavations					
	2512205	Physical and Constitutive Modelling in Geomechanics					
4.	**Program Elective-IV**		PE	3	0	0	3
	2512206	Foundations on Expansive Soils					
	2512207	Pavement Analysis and Design					
	2512208	Soil Dynamics and Machine Foundations					
5.	2512251	Sub soil Exploration Lab	PC	0	0	4	2
6.	2512252	Geotechnical Engineering Modelling Lab	PC	0	0	4	2
7.	2512253	Comprehensive Viva Voce	PC	0	0	0	2
8.	2598281	Quantum Technologies and Applications	MC	2	0	0	2
9.	**Audit Course–II**		AC	2	0	0	0
	25HS201	Pedagogy Studies					
	25HS202	Personality Development through Life Enlightenment Skills					
	25HS203	Yoga for Stress Management					
			TOTAL	**16**	**0**	**8**	**20**

* Students have to undergo an Industry Internship during Summer break in II-Semester for 06 to 08 weeks duration.

III-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	**Program Elective-V**		PE	3	0	0	3
	2512301	Stability Analysis of Slopes					
	2512302	Designing with Geosynthetics					
	2512303	Geotechnical Earthquake Engineering					
2.	2512351	Dissertation Phase–I	PR	0	0	20	10
3.	2512352	Industry Internship	PC	0	0	0	2
4.	2512353	Co-curricular Activities	MC	0	0	0	1
5.		Open Elective	OE	3	0	0	3
			TOTAL	**6**	**0**	**20**	**19**

OPEN ELECTIVE

S.No.	Course Code	Course Name	Offered by Dept.
1	2512381	Green Buildings	Civil
2	2512382	Road Safety Engineering	
3	2598381	Advanced Data Structures & Algorithms	CSE
4	2598382	Cloud Computing	
5	2598383	AI Tools	
6	2584381	IoT and its Applications	ECE
7	2552381	Photovoltaic Systems	EEE
8	2599381	Integrated Product Design and Development	ME
9	25HS381	Advanced Numerical Methods and Computational Mathematics	Mathematics
10	25HS382	Mathematics for Machine Learning and Data Science	
11	25HS383	Statistical Learning Theory and Mathematical Foundations of AI	
12	25HS384	Chemistry of Nanomaterials and Applications in Engineering	Chemistry
13	25HS385	Photonics For Engineers	Physics

IV-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2512451	Dissertation Phase-II	PR	0	0	32	16
			TOTAL	**0**	**0**	**32**	**16**

2512101	M.Tech., I-SEMESTER ADVANCED SOIL MECHANICS (GEOTECHNICAL ENGINEERING)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Demonstrate the compressibility and consolidation behaviour of soils under various loading conditions.

CO2. Analyse the shear strength behaviour of soils under different drainage conditions.

CO3. Apply the stress path concepts to predict soil behaviour under various loading and boundary conditions.

CO4. Evaluate the behaviour of soils using critical soil mechanics concepts.

CO5. Distinguish between elastic and plastic deformations in soil.

SYLLABUS:

UNIT- I: GEOSTATIC STRESSES AND COMPRESSIBILITY OF SOILS (12 Periods)

Concept of stress for a particulate system, Effective stress principle, Geostatic stresses consolidation theory (one-, two-, and three-dimensional consolidation theories), consolidation in layered soil and consolidation for time dependent loading, determination of coefficient of consolidation (Casagrande method and Taylor's method)

UNIT- II: FLOW THROUGH SOILS AND STRENGTH BEHAVIOUR OF SOILS (08 Periods)

Permeability, seepage, mathematical analysis – Finite difference formulae for steady state and transient flows – flow nets – computation of seepage – uplift pressure, and critical hydraulic gradient. Mohr Circle of Stress; UU, CU, CD tests, drained and undrained behavior of sand and clay, significance of pore pressure parameters; determination of shear strength of soil; Interpretation of triaxial test results.

UNIT- III: STRESS PATH (08 Periods)

Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

UNIT- IV: CRITICAL STATE SOIL MECHANICS (09 Periods)

Critical state parameters, critical state for normally consolidated and over consolidated soil, Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. critical void ratio, effect of dilation in sands, different dilation models.

UNIT- V: ELASTIC AND PLASTIC DEFORMATIONS (08 Periods)

Elastic wall, introduction to yielding and hardening, yield curve and yield surface, associated and non-associated flow rule.

Total Periods: 45

Textbooks:

T1. Advanced Soil Mechanics, Das, B.M., Taylor and Francis, 2nd Edition, 1997.

T2. Soil Mechanics in Engineering Practice, Terzaghi, K., and Peck, R.B., John Wiley & Sons, 1967.

Reference Books:

R1. The Mechanics of Soils: An introduction to Critical soil mechanics, Atkinson, J.H. and Brans by, P.L, McGraw Hill, 1978.

R2. An introduction to the Mechanics of soils and Foundation, Atkinson J.H, McGraw- Hill Co., 1993

Web Resources:

1. https://onlinecourse.nptel.ac.in/noc25 ce118/preview
2. https://nptel.ac.in/courses/105103177
3. https://nptel.ac.in/courses/105103207

2512102	M.Tech., I-SEMESTER SUBSURFACE INVESTIGATION AND INSTRUMENTATION (GEOTECHNICAL ENGINEERING)	L	T	P	C
		3	0	0	3

Pre-Requisites: Foundation Engineering

COURSE OBJECTIVES:

On successful completion of the course, student will be able to

CO1. Demonstrate the scope, objectives and stages of subsoil exploration and develop the ability to plan effective exploration programs for geotechnical projects

CO2. Demonstrate the various methods of open excavation and boring, including auger, wash, rotary, percussion, and core drilling techniques used for soil and rock investigation

CO3. Identify different types of soil samples and sampling equipment, and evaluate factors influencing sample quality, disturbance, and preservation

CO4. Gain practical knowledge of conducting and interpreting major in-situ tests such as SPT, CPT, vane shear, plate load, pressure meter, and field permeability tests

CO5. Demonstrate and apply geophysical methods, including electrical resistivity and seismic refraction techniques, for subsoil exploration and report preparation

SYLLABUS:

UNIT-I: INTRODUCTION TO SUBSURFACE EXPLORATION (08 Periods)

Scopes and objectives of explorations – Planning a subsurface exploration – Stages in sub surface exploration – Explorations for preliminary and detailed design – Spacing and depth of exploration

UNIT-II: OPEN EXCAVATION AND BORINGS OF EXPLORATION (08 Periods)

Pits and Trenches – Drifts and Shafts – Methods of boring – Auger Borings – Wash Borings – Rotary Drilling – Percussion Drilling – Core Drilling

UNIT-III: SOIL SAMPLES AND SAMPLERS (09 Periods)

Types of soil samples – Disturbed samples – Undisturbed samples – Design features affecting the sample disturbance – Split spoon samplers – Scraper Bucket Samplers – Shelby Tubes and Thin-walled Samplers – Piston Samplers – Denison Samplers – Preservation and handling of samples

UNIT-IV: IN-SITU TESTING (11 Periods)

Field tests – Standard Penetration Tests – Cone Penetration Tests – In-situ Vane Shear Test – Plate Load Test, monotonic and cyclic – Field Permeability Tests – In-situ Tests using Pressure meter – Observation of Ground Water Table – Instrumentation in soil engineering, strain gauges, resistance and inductance type.

UNIT-V: GEOPHYSICAL METHODS (09 Periods)

Introduction – Electrical Resistivity Methods – Electrical Profiling Method – Electrical Sounding Method – Seismic Methods – Seismic refraction method – Sub-soil Investigation Report

Total Periods: 45

Textbooks:

T1. Soil Mechanics and Foundation Engineering, Dr. K. R. Arora, Standard Publishers, New Delhi, 2020, 7th Edition Reprint.

T2. Soil Mechanics & Foundation Engineering, V. N. S. Murthy, CBS Publishers, New Delhi, 2018.

T3. Geotechnical Engineering, C. Venkat Ramaiah, New Age International, New Delhi, 2018, 6th Edition.

Reference Books:

R1. SP36- Compendium of Indian Standards on Soil Engineering – Part –II

R2. Sub Surface Exploration and Sampling of Soils for Civil Engineering Purpose, M. Juul Hvorslev, Water-ways Station, Vicksburg, Mississippi, 1949.

R3. A Short Course in geotechnical Site Investigation, Noel Simons, Bruce Menzies and Marcus Matthews, Thomas Telford.

R4. Introduction to Geophysical Prospecting, Milton B. Dobrin and Carl H. Savit, McGraw-Hill Publishers, New York.

Web Resources:

1. https://nptel.ac.in/course/105101005
2. https://nptel.ac.in/course/105105104
3. https://nptel.ac.in/course/105101006
4. https://nptel.ac.in/course/105107156

2512103	M.Tech., I-SEMESTER ENGINEERING ROCK MECHANICS (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-I)	L	T	P	C
		3	0	0	3

Pre-Requisites: Engineering Geology

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Classify intact rocks and rock masses using various geotechnical and geo engineering classification systems

CO2. Determine physical and mechanical properties of rocks through laboratory and in-situ testing, and interpret test results for engineering applications.

CO3. Analyze rock behavior under different stress conditions and apply strength criteria to evaluate rock performance in engineering structures.

CO4. Assess the stability of rock slopes and foundations, identify potential failure modes, and propose appropriate stabilizing or strengthening measures.

CO5. Design and plan safe blasting and excavation operations for both surface and underground projects

SYLLABUS:

UNIT- I: ENGINEERING CLASSIFICATION OF ROCKS (10 Periods)

Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Norwegian Geotechnical Classification (Q-system), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geo engineering classification.

UNIT- II: LABORATORY AND IN - SITU TESTING OF ROCKS (08 Periods)

Physical properties, Compressive strength, Tensile strength, Direct shear test, Triaxial shear test, Slake durability test, Schmidt rebound hardness test, Sound velocity test, In-Situ Tests: Seismic methods, Electrical resistivity method, In situ stresses, Plate loading test, Goodman jack test, Plate jacking test, In-situ shear test, Field permeability test.

UNIT- III: STRENGTH, MODULUS AND STRESSES - STRAIN RESPONSES OF ROCKS (10 Periods)

Factors influencing rock response, Strength criteria for isotropic intact rocks, Modulus of intact rocks, effect of confining pressure, Uniaxial Compressive strength, Strength criteria for intact rocks, Strength due to induced anisotropy in rocks, Stress Strain Models: Constitutive relationships, Elastic, Elasto-plastic, Visco-elastic, Elasto visco plastic stress-strain models.

UNIT- IV: STABILITY OF ROCK SLOPES AND FOUNDATIONS ON ROCKS (10 Periods)

Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, Wedge method of analysis, buckling failure, Toppling failure, Improvement of slope stability and protection.

Foundations on Rock: Introduction, Estimation of bearing capacity, Stress distribution, sliding stability of dam foundations, strengthening measures, Settlements in rocks, bearing capacity of pile/pier in rock, Remedial measures, Foundations located on edge of jointed slope.

UNIT- V: UNDERGROUND AND OPEN EXCAUVATIONS (07 Periods)

Blasting operational planning, Explosive products, Blast Design, Underground blast design, Controlled blasting techniques, blasting damage and control, Safe practice with explosives and shots.

Total Periods: 45

Textbooks:

T1. Introduction to Rock mechanics, Goodman, Willey International, 1980.
T2. Engineering in Rocks for slopes, foundations and tunnels, Ramamurthy, T., Prentice Hall of India, 2007.
T3. Fundamentals of Rock Mechanics, Jaeger, J. C. and Cook, N. G. W., Chapman and Hall, London, 1979.

Reference Books:

R1. Underground Excavation in Rock, Hoek, E. and Brown, E.T., Institution of Mining and Metallurgy, 1982.
R2. Rock Mechanics for Underground Mining, Brady, B. H. G. and Brown, E. T., Chapman & Hall, 1993.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc24_ce93/preview
2. https://onlinecourses.nptel.ac.in/noc23_ce13/preview
3. https://nptel.ac.in/courses/105107208

2512104	M.Tech., I-SEMESTER CRITICAL SOIL MECHANICS (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-I)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Analyze stress and strain states in soils and interpret stress-strain paths from laboratory tests

CO2. Determine critical state parameters from drained and undrained tests and construct state boundary surfaces

CO3. Demonstrate and predict behavior of normally consolidated and over consolidated clays using Hvorslev surface

CO4. Analyze behavior of sands using critical state framework including dilatancy and state parameter concepts

CO5. Apply elasto-plastic constitutive models (Cam-Clay, Modified Cam-Clay) to predict soil behavior before failure

SYLLABUS:

UNIT-I: STRESS AND STRAIN IN SOIL MECHANICS (09 Periods)

Review of continuum mechanics and tensor notation- State of stress in soils : total, effective, and neutral stresses - Stress invariants: mean stress (p), deviatoric stress (q) - Stress tensor, principal stresses and stress transformation- Mohr's circle representation in 3D stress space State of strain: volumetric and shear strains - Strain invariants and dilatancy - Stress paths and strain paths - Stress- dilatancy relationships - Laboratory experiments: triaxial, simple shear, direct shear- True triaxial and hollow cylinder apparatus-Interpretation of test data using stress and strain variants - Normalized soil behavior parameters

UNIT-II: CRITICAL STATE LINE AND ROSCOE SURFACE (09 Periods)

Critical state concept: historical development - Original Cam-Clay research (Roscoe, Schofield, Wroth)-Families of undrained triaxial tests- Plotting undrained test results in q-p and v-p spaces - Undrained stress paths and pore pressure response - Families of drained triaxial tests - Drained stress paths and volume change behavior - Constant p tests and K0 consolidation

Critical State Line (CSL): definition and significance - CSL in q-p space and v-ln p space - Uniqueness of CSL and testing considerations - Roscoe surface: isotropic normal compression line-State boundary surface concept- Drained and undrained surfaces for normally consolidated soils - Yield surfaces and plastic potential

UNIT-III: OVERCONSOLIDATED SOILS AND HVORSLEV SURFACE (09 Periods)

Over consolidation: Causes and definition - Over consolidation ratio (OCR)and stress history - Yield stress determination methods - Behavior of over consolidated samples in undrained tests- Pore pressure parameters A and B- Behavior of over consolidated samples in drained tests - Swelling and recompression behavior - Hvorslev surface: tension cutoff - Hvorslev parameters(φ'cv,c')- complete state boundary surface - Wet and dry sides of critical state - Volume changes during shearing - Dilatancy and contractancy behavior - Pore water pressure changes during undrained shear- Brittleness and ductility in over consolidated clays- Peak and residual strength relationships.

UNIT-IV: BEHAVIOUR OF SANDS (09 Periods)

Critical state framework for sands - Applicability and limitations for granular tests - Influence of particle characteristics - Normalized plots: q/p' vs. volumetric strain - State parameter concept (ψ) - Effect of initial density and confining pressure - Bolton's dilatancy theory - Dilatancy in dense sands- Contractancy in loose sands- Phase transformation line-Taylor's model for sand behavior - Steady state concept - Consequences and limitations of Taylor's model - Liquefaction and cyclic mobility - Norsand and other state parameter models

UNIT-V: ELASTO - PLASTIC MODELING (09 Periods)

Fundamentals of elasticity and plasticity theory - Elastic and plastic deformations: separation - Incremental stress-strain relationships - Plasticity theory: yield surface, flow rule, hardening- Associated and non-associated flow rules - Drucker's stability postulates- Development of elasto-plastic models based on CSSM - Derivation from thermodynamic principles - Original Cam-Clay model - Formulation: yield surface, flow rule, hardening law- Stress-strain predictions and limitations- Modified Cam-Clay model- Improvements over original model- Numerical implementation considerations

Total Periods: 45

Textbooks:

T1. The Mechanics of Soils: An Introduction to Critical State Soil Mechanics. Atkinson, J.H. and Brans P.L., London, UK: McGraw-Hill, 1978 ISBN: 978-0070841284

T2. Soil Behaviour and Critical State Soil Mechanics, Cambridge, Wood, D.M.. UK: Cambridge University Press., 1990 ISBN: 978-0521337823

T3. Geotechnical Modelling. Muir Wood, D., London, UK: Spon Press., 2004 ISBN:978-0419237006

Reference Books:

R1. Critical State Soil Mechanics, Schofield, A.N. and Wroth, C.P. (1968). London, UK: McGraw- Hill. (Classic text, reprinted 2000 by McGraw-Hill)

R2. Bolton, M.D.. The strength and dilatancy of sands, Géotechnique, vol. 36, no. 1, pp. 65-78, 1986.

Web Resources:

1. https://archive.nptel.ac.in/courses/105/105/105105202/(NPTEL-AdvancedSoil Mechanics)
2. https://www.soilmodels.com/(SoilConstitutiveModels Resource)
3. https://www.imperial.ac.uk/geotechnics/research/critical-state-soil-mechanics/
4. https://web.mit.edu/1.37/www/(MITSoilBehaviorCourse)
5. https://archive.nptel.ac.in/courses/105/106/105106051/
6. https://www.geoengineer.org/education/web-class/advanced-soil-mechanics
7. https://ocw.tudelft.nl/courses/advanced-soil-mechanics/
8. https://www.youtube.com/playlist?list=PLjZnhUwcjZmLgFq3WF9J7U1X-CSSM(Lecture Series)
9. https://www.civil.iisc.ac.in/~akg/Sandbook.pdf(SandMechanicsResources)

2512105	M.Tech., I-SEMESTER ENVIRONMENTAL GEOTECHNOLOGY (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-I)	L	T	P	C
		3	0	0	3

Pre-Requisites: Environmental Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Analyze the soil structure and multiphase interactions, Assess the soil-water relationship in various environmental settings

CO2. Demonstrate the major soil minerals and correlate with engineering properties, Employ modern tools for mineralogical assessment

CO3. Analyze the diffuse double layer models and ion exchange in soils, Predict contaminant behavior using modern interactive models

CO4. Design containment and remediation strategies for waste-impacted sites, Assess and analyze contaminant fate in subsurface media

CO5. Design landfill systems including liners, covers, leachate & gas management; assess their environmental performance

SYLLABUS:

UNIT-I: SOIL AS A MULTIPHASE SYSTEM & ENVIRONMENT INTERACTION (09 Periods)

Soil as a multiphase (solid-liquid-gas) system—basic concepts and modern advances - Properties of water in porous media: capillarity, surface tension, adsorption, permeability - Soil-environment interactions: heat, gases, moisture, contaminants - The hydrological cycle with emphasis on infiltration, runoff, and soil moisture dynamics - Latest developments: digital water cycle models, climate interaction with soil media

UNIT-II: SOIL MINERALOGY AND ITS ENGINEERING SIGNIFICANCE (09 Periods)

Soil minerals: clay, silt, sand, and their structures - Significance of mineralogy: swelling, compressibility, permeability, contaminant retention - X-ray diffraction, scanning electron microscopy, and modern spectroscopic techniques - Case studies: mineralogy and geotechnical problems

UNIT-III: SOIL-WATER-CONTAMINANT MECHANISMS (09 Periods)

Soil-water interaction: diffuse double layer, electric forces, and water structure - Attraction/ repulsion forces, vander Waals, and electrostatic interactions - Soil-water-contaminant interactions: sorption, desorption, diffusive and advective transport - Ion exchange, CEC, soil-organic/inorganic reactions - Modern DDL models (e.g., Stern, Gouy-Chapman) and their environmental relevance

UNIT-IV: WASTE CONTAINMENT, TRANSPORT, AND REMEDIATION (09 Periods)

Types, sources, and classification of wastes - Environmental laws (e.g., MSW, HW rules, RCRA) and regulatory standards - Soil and groundwater hydrology, contaminant pathways (advection, dispersion, reaction) - Physicochemical properties for retention and transport - Remediation technologies: in situ/ex situ, stabilization / solidification, biological and chemical treatment - Contaminated site risk assessment and remediation planning

UNIT-V: **SOIL CHARACTERIZATION, LANDFILL DESIGN & REMEDIATION**

(09 Periods)

Advanced soil characterization: water content, gas permeability, electrical/thermal property testing, pore-size distribution - Analytical techniques: spectroscopy, ICP-MS, contaminant detection - Landfill concepts: site assessment, landfill design (liners, covers, leachate/gas control, monitoring) - Remediation and stabilization of contaminated soils: barriers, slurry walls, performance and monitoring, risk assessment frameworks - End uses for remediated sites and reclamation practices

Total periods: 45

Textbooks:

T1. Geotechnical Practice for Waste Disposal, David E. Daniel, Springer,1993 First Edition
T2. Fundamentals of soil Behaviour, James K Mitchelle, Kenichi Soga, Wiley, 2005, Third Edition
T3. Geo environmental Engineering: Principles and Applications, Reddi, L.N. & Inyang, H., Taylor and Francis, 2000.

Reference Books:

R1. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Sharma, H.D. & Reddy, L.N., Wiley, 2004.
R2. Waste Containment Systems, Waste Stabilization and Landfills, Gourc, J.P., Wiley, 1994.

Web Resources:

1. Frontiers in Soil Science – Water & Soil Quality
2. MIT OCW: Waste Containment and Remediation
3. Advanced Soil Characterization NPTEL
4. MIT OCW: Waste Containment and Remediation
5. NIUA: Landfill Remediation Training Manual

		L	T	P	C
2512106	**M.Tech., I-SEMESTER** **FINITE ELEMENTS METHODS IN GEOMECHANICS** (GEOTECHNICAL ENGINEERING) **(PROGRAM ELECTIVE-II)**	**3**	**0**	**0**	**3**

Pre-Requisites: Finite Elements Methods

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain fundamental FEM concepts, discretization, and element formulation for geotechnical applications

CO2. Apply variational principles, Ritz method, and Galerkin method to formulate geotechnical boundary value problems

CO3. Analyze one-dimensional and two-dimensional problems including consolidation, seepage, and stress-deformation

CO4. Implement advanced constitutive models, solve nonlinear problems, and analyze coupled hydro-mechanical behavior

CO5. Apply commercial FEM software to practical geotechnical problems including foundations, slopes, excavations, and tunnels

SYLLABUS:

UNIT-I: FUNDAMENTALS OF FINITE ELEMENT METHOD (10 Periods)

Introduction to continuum mechanics, field equations, and PDEs in geomechanics. - Historical development, recent advances, and real-world applications of FEM - Discretization of geotechnical problems; mesh design concepts - Types of finite elements: 1D (bars), 2D (triangles/quadrilaterals), advances in 3D element technology - Shape functions and interpolation methods; superior element formulations (e.g., spectral, higher-order elements) - Process of assembling the global system - Application of boundary conditions, pre- and post-processing.

UNIT-II: VARIATIONAL METHODS AND WEAK FORMULATIONS (08 Periods)

Calculus of variations: motivation, historical trends, current developments (e.g., computer-aided symbolic solutions) - Euler-Lagrange equation; minimum potential energy - Principle of virtual work in modern computation - Weighted residual methods with focus on Galerkin and Ritz techniques - Weak formulations, error estimation, and advanced error control in modern FEM - Application to classical and modern geomechanics problems (including sustainability and multi-physics trends).

UNIT-III: ELEMENT FORMULATION AND 2D PROBLEMS (10 Periods)

Formulation of 1D bar and seepage elements - Assembly/solution for 1D and 2D mesh (focus on large-scale, high-speed current trends) - 2D elements: Constant Strain Triangle (CST), linear triangle, various quadrilaterals - Natural coordinate systems, numerical integration (Gaussian quadrature, contemporary integration) - Stress/strain calculations and advanced post-processing techniques.

UNIT-IV: ADVANCED FORMULATIONS AND NON-LINEAR ANALYSIS (09 Periods)

Isoperimetric element concept and formulation - Overview of 3D elements - Constitutive modeling: elastic and advanced elasto-plastic (Mohr-Coulomb, Drucker-Prager), current industry trends - Material/geometry nonlinearity and the Newton-Raphson method - Consolidation theory; coupled fluid-mechanical analysis - Dynamic analysis basics; survey of modern research applications.

UNIT-V: APPLICATIONS IN GEOTECHNICAL ENGINEERING (08 Periods)

Overview of commercial software used in geotechnical FEM (PLAXIS, SIGMA/W, Rocscience, FEAP) - Shallow foundation analysis (bearing capacity, settlement, safety) - Slope stability and deformation analysis using FEM—advanced failure and monitoring techniques - Retaining wall, seepage, and coupled analyses in practice - Meshing, boundary condition selection, result interpretation, validation - Case histories from recent literature and industry.

Total Periods: 45

Textbooks:

T1. Programming the Finite Element Method, Smith, I.M. and Griffiths, D.V., Chichester, John Wiley & Sons., UK, 2004. ISBN: 978-0470849705

T2. Finite Element Analysis in Geotechnical Engineering: Theory, Potts, D.M. and Zdravkovic, L., Thomas Telford Publishing, London, UK, 1999. ISBN: 978-0727727831

T3. Finite Element Analysis in Geotechnical Engineering: Application, Potts, D.M. and Zdravkovic, L. Thomas Telford Publishing, London, UK, 2001. ISBN: 978-0727729842

Reference Books:

R1. The Finite Element Method: Its Basis and Fundamentals, Zienkiewicz, O.C., Taylor, R.L., and Zhu, J.Z. Oxford, UK: Butterworth-Heinemann, 2013, 7th Edition, ISBN: 978-1856176330

R2. Introduction to the Finite Element Method, Reddy, J.N., McGraw-Hill Education, New York, USA, 2019. ISBN: 978-1259861901

R3. Concepts and Applications of Finite Element Analysis, Cook, R.D., Malkus, D.S., Plesha, M.E., and Witt, R.J., New York, USA: John Wiley & Sons, 2001. 4th Edition, ISBN: 978-0471356059

R4. Introductory Finite Element Method, Desai, C.S. and Kundu, T., Boca Raton, FL, USA: CRC Press, 2001. ISBN: 978-0849303999

R5. PLAXIS Manual, Brinkgreve, R.B.J., Kumarswamy, S., and Swolfs, W.M. Delft, Netherlands: PLAXIS, 2018

R6. Stress-Deformation Modeling with SIGMA/W. Calgary, GEO-SLOPE International Ltd., Canada, 2020.

R7. Nonlinear Analysis in Soil Mechanics, Chen, W.F. and Mizuno, E. Amsterdam, Netherlands: Elsevier Science Publishers, 1990. ISBN: 978-0444874566

Web Resources:

1. https://archive.nptel.ac.in/courses/105/106/105106051/
   https://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/
2. https://feaforall.com/
3. https://archive.nptel.ac.in/courses/105/105/105105202/
4. https://www.12000.org/my_notes/index.htm
5. https://github.com/topics/finite-element-method
6. https://www.imperial.ac.uk/geotechnics/software/icfep/
7. https://www.plaxis.com/support/training/

8. https://www.geo-slope.com/support/video-tutorials
9. https://www.plaxis.com/support/tutorials-and-manuals/
10. https://www.geo-slope.com/resources/case-studies
11. https://www.geoengineer.org/education/web-based-courses
12. https://www.issmge.org/education/online-learning
13. https://www.rocscience.com/learning/webinars

2512107	M.Tech., I-SEMESTER COMPUTATIONAL GEOMECHANICS (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-II)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Apply iterative numerical techniques such as Bisection, Newton-Raphson, Jacobi, and Gauss- Seidel methods to solve engineering equations.

CO2. Implement finite difference and finite element methods for modeling soil behavior and solve boundary value problems in geotechnical engineering.

CO3. Perform statistical analysis including correlation and regression to interpret soil properties and geotechnical investigation results.

CO4. Analyze consolidation behavior of soils using theoretical, finite difference, and finite element solutions to predict settlement and pore pressure dissipation.

CO5. Conduct probabilistic risk assessments for geotechnical site characterization and design safer, more reliable foundation systems.

SYLLABUS:

UNIT- I: SOLUTION OF NON - LINEAR AND LINEAR EQUATIONS (09 Periods)

Bisection, False Position, Newton-Raphson, Successive Approximation Method, Iterative Methods, Jacobi's Method, Gauss Seidal Method, Successive over Relaxation Method.

UNIT- II: FINITE DIFFERENCE AND FINITE ELEMENT METHOD (08 Periods)

Two Point Boundary Value Problems – Disichlet Conditions, Neumann Conditions; Ordinary and Partial Differential Equations. Fundamentals, Constitutive Finite Element Models for Soils.

UNIT- III: CORRELATION AND REGRESSION ANALYSIS (10 Periods)

Correlation - Scatter Diagram, Karl Pearson Coefficient of Correlation, Limits of Correlation Coefficient; Regression – Lines of Regression, Regression Curves, Regression Coefficient, Differences between Correlation and Regression Analysis.

UNIT- IV: ONE DIMENSIONAL CONSOLIDATION (10 Periods)

Theory of Consolidation, Analytical Procedures, Finite Difference Solution Procedure for Multi layered Systems, Finite Element Formulation

UNIT-V: FLOW THROUGH POROUS MEDIA AND RISK ASSESSMENT IN GEOTECHNICAL ENGINEERING (08 Periods)

Geotechnical Aspects, Numerical Methods, Applications and Design Analysis, Flow in Jointed Media, Probabilistic Site Characterization and Design of Foundations

Total Periods: 45

Textbooks:

T1. Numerical Methods in Geotechnical Engineering, S. Chandra kant., Desai and John Christian,, Mc. Graw Hill Book Company, 1977.

T2. Numerical Methods for Scientific and Engineering Computations, M.K. Jain, S.R.K. Iyengar and R.K. Jain, Third Edition, New Age International(P) Ltd. Publishers, New Delhi.

Reference Books:

R1. Finite Elements in Geotechnical Engineering", D.J. Naylor and G.N. Pande, Pine ridge Press Ltd., UK.
R2. "Applied Soil Mechanics", Sam Helwany, John Wiley & Sons, Inc.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc24_ma54/preview
2. https://nptel.ac.in/courses/105106222
3. https://onlinecourses.nptel.ac.in/noc20_ma30/preview

2512108	M.Tech., I-SEMESTER SOIL STRUCTURE INTERACTION (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-II)	L	T	P	C
		3	0	0	3

Pre-Requisites: Foundation Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the fundamental concepts of soil–foundation interaction and describe various soil, foundation, and interface behaviors.

CO2. Apply different soil response models such as Winkler, elastic continuum, and two-parameter models for foundation analysis.

CO3. Analyze the behavior of beams and plates resting on elastic media using theoretical and numerical approaches

CO4. Evaluate the response of axially and laterally loaded single piles and pile groups considering elastic and interaction effects.

CO5. Assess the influence of ground–foundation–structure interaction under static and dynamic loading conditions.

SYLLABUS:

UNIT-I: SOIL - FOUNDATION INTERACTION (12 Periods)

Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior.

UNIT-II: BEAM ON ELASTIC FOUNDATION (08 Periods)

Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

UNIT-III: PLATE ON ELASTIC MEDIUM (10 Periods)

Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

UNIT-IV: ANALYSIS OF AXIALLY AND LATERALLY LOADED PILES AAND PILE GROUPS (10 Periods)

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap, Load deflection prediction for laterally loaded piles, Sub grade reaction and elastic analysis, Interaction analysis, Pile-raft system.

UNIT-V: GROUND - FOUNDATION - STRUCTURE INTERACTION (05 Periods)

Effect of structure on ground-foundation interaction, Static and dynamic loads.

Total Periods: 45

Textbooks:

T1. Elastic Analysis of Soil-Foundation Interaction, Selvadurai, A.P.S, Elsevier, 1979.
T2. Pile Foundation Analysis and Design, Poulos, H.G. and Davis, F.H, Wiley and Sons 1980

Reference Books:

R1. Pile Foundation Analysis and Design, Poulos, H.G Davis, E.H., JohnWiley, 1980.

R2. Structures of Interaction State of Art Report, Institution of Structural Engineers, 1978.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview
2. https://nptel.ac.in/courses/108104139
3. https://nptel.ac.in/courses/108106172
4. https://nptel.ac.in/courses/117106108

2512151	M.Tech., I-SEMESTER SOIL MECHANICS - I LAB (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	4	2

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Determine basic soil properties and interpret their significance in soil identification and classification.

CO2. Conduct Atterberg limits and visual classification tests and classify soils as per standard engineering systems.

CO3. Assess in-situ soil density using core cutter and sand replacement

CO4. Perform Proctor compaction tests to establish compaction characteristics of soils and relate them to field compaction requirements in engineering projects.

CO5. Evaluate engineering soil parameters through permeability and consolidation tests and interpret their influence on seepage, settlement, and overall soil behavior.

List of Experiments:

1. Determination of Moisture Content and Specific Gravity
2. Grain Size Analysis
3. Determination of Atterberg's Limits
4. Visual Classification Test for Soils
5. Determination of In-Situ Densities
   a) Core Cutter Method
   b) Sand Replacement Method
6. Proctor Compaction
   a) Standard Proctor Compaction
   b) Modified Proctor Compaction
7. Determination of Coefficient of Permeability
   a) Constant Head Method
   b) Variable Head Method
8. Consolidation Test

Textbooks:

T1. Soil Testing for Engineers, S.Mittal and JP Shukla, Khanna Publishers, New Delhi, 2008.

T2. Soil Testing–Laboratory Manual & Question Bank, KVS Apparao and VCS Rao, University Science Press, New Delhi, 2013.

Reference Books:

R1. Compendium of Indian Standards on Soil Engineering: Part–1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.

R2. Braja M. Das, Soil Mechanics Laboratory Manual, Oxford University Press, New York, 2002

Web Resources:

1. https://nptel.ac.in/courses/105101160

2512152	M.Tech., I-SEMESTER SOIL MECHANICS-II LAB (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	4	2

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Determine shear strength parameters of soils and interpret their relevance in geotechnical design.

CO2. Evaluate bearing capacity characteristics of sub grade soils and apply results for pavement and foundation design.

CO3. Assess undrained shear strength of cohesive soils using the Laboratory Vane Shear test and relate the results to field stability problems.

CO4. Determine swelling characteristics of expansive soils using the Swell Pressure Test and interpret their impact on structures, pavements, and foundations.

CO5. Analyze soil chemical properties by determining Total Soluble Solids and Calcium Carbonate content and evaluate their influence on soil behavior and engineering performance.

List of Experiments:

1. Direct Shear Test
2. Unconfined Compression Test
3. Triaxial Shear Test– UU, CU, CD Tests
4. California Bearing Ratio
5. Laboratory Vane Shear Test
6. Swell Pressure Test
7. Total Soluble Solids Content in Soils
8. Calcium Carbonate Content in Soils

Textbooks:

T1. Soil Testing for Engineers, S. Mittal and JP Shukla, Khanna Publishers, New Delhi, 2008.

T2. Soil Testing–Laboratory Manual & Question Bank, KVS Apparao and VCS Rao, University Science Press, New Delhi, 2013.

Reference Books:

R1. Compendium of Indian Standards on Soil Engineering: Part–1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.

R2. Soil Mechanics Laboratory Manual, Braja M .Das, Oxford University Press, New York, 2002

Web Resources:

1. https://nptel.ac.in/courses/105101160

2512153	M.Tech., I-SEMESTER GEOSTUDIO (SKILL ENHANCEMENT COURSE)	L	T	P	C
		0	1	2	2

Pre-Requisites: Nil

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Analyze rainfall-induced slope instability by coupling seepage and slope stability modules to determine safety factor variations

CO2. Evaluate the stability of embankments and dams under rapid drawdown conditions using transient seepage analysis

CO3. Apply various slip surface methods to assess the stability of natural and engineered soil and rock slopes

CO4. Able to apply appropriate Tools and Techniques to understand and analyse the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

SYLLABUS:

1. Coupling SEEP and SLOPE modules to obtain the change in safety factor of slopes after rainfall
2. Analysis of complex problems involving rapid water level changes
3. Stability assessment for soil and rock slopes using various slip surface methods
4. Static stress and deformation modeling in soil or rock, including settlement analysis
5. Seismic response analysis and computation of inertial forces during earthquakes
6. Assessment procedures examining how loose sands can collapse and liquefy at strengths below peak strength
7. Simulations of contaminant transport highly related to total head conditions
8. Heat and mass transfer analysis in soil and rock materials
9. Compaction and consolidation simulations for soil settlements
10. Modeling of dewatering systems and groundwater control
11. 3D finite element groundwater seepage analysis to generate complex water conditions
12. Analysis of air movement through porous media
13. Integration of SLOPE/W, SEEP/W, and SIGMA/W to solve complex real-world problems with realistic results

Textbooks:

T1. GeoStudioModeling with SLOPE/W: An Engineering Methodology, Krahn, J., GEO-SLOPE International Ltd., Calgary, Alberta, Canada, 2020.

T2. GeoStudioModeling with SEEP/W: An Engineering Methodology, Krahn, J. GEO-SLOPE International Ltd., Calgary, Alberta, Canada, 2019.

T3. Soil Strength and Slope Stability. Duncan, J.M., Wright, S.G., and Brandon, T.L., John Wiley & Sons, Hoboken, New Jersey, 2014, 2nd Edition.

T4. Soil Mechanics for Unsaturated Soils, Fredlund, D.G. and Rahardjo, H. John Wiley & Sons, New York, 1993.

Reference Books:

R1. SLOPE/W User's Guide: Stability Modeling with SLOPE/W, GEO-SLOPE International Ltd., Calgary, Alberta, Canada, 2021.

R2. SEEP/W User's Guide: Groundwater Modeling with SEEP/W., GEO-SLOPE International Ltd. Calgary, Alberta, Canada, 2021.

R3. SIGMA/W User's Guide: Stress-Deformation Modeling with SIGMA/W, GEO-SLOPE International Ltd., Calgary, Alberta, Canada, 2021.

R4. GEO-SLOPE International Ltd. (2021). QUAKE/W User's Guide: Dynamic Earthquake Modeling with QUAKE/W. Calgary, Alberta, Canada.

R5. Slope Stability and Stabilization Methods, Abramson, L.W., Lee, T.S., Sharma, S., and Boyce, G.M. John Wiley & Sons, New York, 2002. 2nd Edition.

R6. Principles of Foundation Engineering. Das, B.M., Cengage Learning, Stamford, CT, 2015, 8th Edition.

R7. Geotechnical Earthquake Engineering, Kramer, S.L. Prentice Hall, Upper Saddle River, New Jersey, 1996.

R8. Groundwater, Freeze, R.A. and Cherry, J.A., Prentice Hall, Englewood Cliffs, New Jersey, 1979.

R9. An Introduction to Geotechnical Engineering, Holtz, R.D., Kovacs, W.D., and Sheahan, T.C., Pearson, Upper Saddle River, New Jersey, 2011, 2nd Edition.

Web Resources:

1. https://www.geoslope.support/
2. https://www.seequent.com/help-support/geostudio/
3. https://www.geoslope.support/kb/article/10-geostudio-reference-manuals/
4. https://www.geoslope.com/support/support-resources/tutorial-videos/
5. https://www.classcentral.com/subject/geotechnical-engineering

		L	T	P	C
2599171	**M.Tech., I-SEMESTER** **RESEARCH METHODOLOGYAND INTELLECTUAL PROPERTY RIGHTS** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (MANDATORY COURSE)	**2**	**0**	**0**	**2**

Pre-Requisites: NIL

COURSE OUTCOMES:

After completion of the course, student will be able to

CO1. Demonstrate the research process, types and methods, use data correctly, follow ethical rules, and use proper citation styles.

CO2. Apply appropriate data collection methods, identify data types and sources, ensure quality, and follow ethical practices using suitable tools.

CO3. Apply multivariate analysis and experimental design to study cause-effect relationships, ensure measurement validity, and write structured research papers and proposals.

CO4. Demonstrate the concept, evolution, and types of Intellectual Property Rights (IPR), recognize global IPR practices and institutions like WIPO, WTO, and UNESCO, and identify key agreements, trade secrets, and biodiversity-related rights.

CO5. Demonstrate the concept, features, and benefits of patents; identify types of patent applications and the filing process; and explain the roles of patent agents, licensing, and patent regulations.

SYLLABUS:

UNIT–I: FUNDAMENTALS OF RESEARCH METHODOLOGY (05 Periods)

Overview of research process and design - Types of Research - Approaches to Research (Qualitative vs Quantitative) - Observation studies, Experiments and Surveys - Use of Secondary and exploratory data to answer the research question - Importance of Reasoning in Research and Research ethics - Documentation Styles (APA/IEEE etc.) - Plagiarism and its consequences.

UNIT-II: DATA COLLECTION AND SOURCES (05 Periods)

Importance of Data Collection - Types of Data - Data Collection Methods - Data Sources - primary, secondary and Big Data sources - Data Quality & Ethics - Tools and Technology for Data Collection.

UNIT-III: DATA ANALYSIS AND REPORTING (06 Periods)

Overview of Multivariate analysis - Experimental research, cause-effect relationship, and development of hypotheses- Measurement systems analysis, error propagation, and validity of experiments - Guidelines for writing abstracts, introductions, methodologies, results, and discussions - Writing Research Papers & proposals.

UNIT- IV: UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS (07 Periods)

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT–V: PATENTS (07 Periods)

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step,

Specification - Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents

Total Periods: 30

Textbooks:

T1. Research Methodology: An introduction for Science & Engineering students, Stuart Melville and Wayne Goddard, Juta and Company Ltd, 2004

T2. Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Catherine J. Holland, Entrepreneur Press, 2007.

References Books:

R1. Business Research Methods, Cooper Donald R, Schindler Pamela S and Sharma JK, Tata McGraw Hill Education, 2012, Eleventh Edition,

R2. Research Methodology: A Step-by-Step Guide for Beginners, David Hunt, Long Nguyen, Matthew Rodgers, Wiley, 2007.

R3. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, Deborah E. Bouchoux, Cengage, 2024, Sixth Edition,

R4. The Craft of Research, Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, University of Chicago Press, 2024, Fifth Edition.

R5. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September, 2013.

Web Resources:

1. Research Methodology and Data Analysis courses, Coursera / edX
2. Latest journals on research design and statistics, Springer Link & ScienceDirect
3. Free access to research papers Google Scholar
4. Open-access research methodology resources, NCBI Bookshelf
5. For fundamentals of hypothesis testing, regression, and ANOVA. Khan Academy (Statistics & Probability)

2599181	M.Tech., I-SEMESTER ENGLISH FOR RESEARCH PAPER WRITING (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-I)	L	T	P	C
		2	0	0	0

Pre-Requisites: NIL

COURSE OUTCOMES:

After completion of the course, student will be able to

CO1. Demonstrate proficiency in academic English by applying MAP principles, using clear, precise, and objective language, structuring coherent paragraphs, integrating references, and employing paraphrasing and appropriate tone in writing.

CO2. Exhibit critical reading skills to analyze academic texts, differentiate between article types, identify arguments and methodologies, evaluate findings, and make effective notes.

CO3. Apply advanced grammar and punctuation to construct clear, accurate, and complex sentences with proper voice, tense consistency, subject-verb agreement, and unambiguous references.

CO4. Revise and refine written work by editing for clarity, coherence, and grammar; proofread for accuracy; and apply effective strategies for professional correspondence and creative writing.

CO5. Demonstrate digital literacy by critically evaluating online content, using AI tools ethically in research writing, generating accurate citations, and practicing plagiarism-free writing with awareness of fair practices.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF ACADEMIC ENGLISH (05 Periods)

Academic English - MAP (Message-Audience-Purpose) - Language Proficiency for Writing - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References - Word order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Structuring Paragraphs - Paraphrasing Skills – Framing Title and Sub-headings

UNIT-II: READING SKILLS FOR RESEARCHERS (06 Periods)

Reading Academic Texts - Critical Reading Strategies - Skimming and Scanning - Primary Research Article vs. Review Article - Reading an Abstract - Analyzing Research Articles - Identifying Arguments - Classifying Methodologies - Evaluating Findings - Making Notes

UNIT-III: GRAMMAR REFINEMENT FOR RESEARCH WRITING (06 Periods)

Advanced Punctuation Usage - Grammar for Clarity - Complex Sentence Structures - Active-Passive Voice - Subject-Verb Agreement - Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

UNIT-IV: MASTERY IN REFINING WRITTEN CONTENT/EDITING SKILLS (07 Periods)

Effective Revisions - Restructuring Paragraph - Editing vs Proofreading, Editing for Clarity and Coherence - Rectifying Sentence Structure Issues - Proofreading for Grammatical Precision – Spellings - Tips for Correspondence with Editors - Critical and Creative Phases of Writing.

UNIT-V: TECHNOLOGY AND LANGUAGE FOR RESEARCH (06 Periods)

Digital Literacy and Critical Evaluation of Online Content - Technology and Role of AI in Research Writing – Assistance in Generating Citations and References - Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

Total Periods: 30

Textbooks:

T1. Academic Writing: A Handbook for International Students. Routledge, Bailey. S. London and New York: 2015.

T2. English for Writing Research Papers, Adrian Wallwork, Springer New York Dordrecht Heidelberg London, 2011.

Reference books:

R1. Writing for Academic Success, Craswell, G., Sage Publications, 2004.

R2. Writing With Power, Peter Elbow, E-book, Oxford University Press, 2007

R3. Writing Academic English, Oshima, A. & Hogue, A., Addison-Wesley, New York, 2005

R4. Academic Writing for Graduate Students: Essential Skills and Tasks, Swales, J. & C. Feak, Michigan University Press, 2012.

R5. Writing for Science, Goldbort R., Yale University Press (available on Google Books), 2006

R6. How to Write and Publish a Scientific Paper, Day R., Cambridge University Press, 2006

Web Resources:

1. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge04/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview
3. "Writing in the Sciences" – Stanford University (MOOC on Coursera) https://www.coursera.org/learn/sciwrite
4. Academic Phrasebank – University of Manchester http://www.phrasebank.manchester.ac.uk
5. OWL (Online Writing Lab) – Purdue University, https://owl.purdue.edu *(Resources on APA/MLA formats, grammar, structure, paraphrasing)*
6. Zotero or Mendeley (Reference Management Tools) – Useful for managing citations and sources.

2512181	M.Tech., I-SEMESTER DISASTER MANAGEMENT (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE - I)	L	T	P	C
		2	0	0	0

Pre-Requisites: Nil

COURSE OUT COMES:

After completion of the course, student will be able to

CO1. Identify and map disaster-prone areas and understand the epidemiological consequences of disasters.

CO2. Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.

CO3. Assess the economic, social, and ecological repercussions of major natural and man-made disasters.

CO4. Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.

CO5. Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.

SYLLABUS:

UNIT–I: INTRODUCTION (06 Periods)

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

UNIT-II: REPERCUSSIONS OF DISASTERS AND HAZARDS (06 Periods)

Economic Damage - Loss of Human and Animal Life - Destruction of Ecosystem - Natural Disasters - Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster - Nuclear Reactor Meltdown - Industrial Accidents - Oil Slick sand Spills - Outbreaks of Disease and Epidemics War and Conflicts

UNIT-III: DISASTER PREPAREDNESS AND MANAGEMENT (06 Periods)

Preparedness - Monitoring of Phenomena - Triggering a Disaster or Hazard - Evaluation of Risk-Application of Remote Sensing - Data from Meteorological and Other Agencies -Media Reports-Governmental and Community Preparedness

UNIT-IV: RISK ASSESSMENT (06 Periods)

Disaster Risk -Concept and Elements, Disaster Risk Reduction - Global and National Disaster Risk Situation -Techniques of Risk Assessment – Global Co-Operation in Risk Assessment and Warning - People's participation Risk Assessment – Strategies for Survival

UNIT-V: DISASTER MITIGATION (06 Periods)

Meaning, Concept and Strategies of Disaster Mitigation – Emerging Trendsin Mitigation - Structural Mitigation and Non- Structural Mitigation - Programs of Disaster Mitigation in India

Total Periods: 30

Textbooks:

T1. Disaster Management, Gupta, H. K, Universities Press, 2003
T2. Natural Hazards and Disaster Management, Singh, R. B., Rawat Publications, 2006.

Reference Books:

R1. Introduction to International Disaster Management, Coppola, D. P., Elsevier, 4th ed., 2020.
R2. Science and Technology in Disaster Risk Reduction in Asia, Shaw, R., & Izumi, T., Springer, 2022.
R3. Handbook of Hazards and Disaster Risk Reduction and Management, Wisner, B., Gaillard, J. C., & Kelman, I., Routledge, 2nd ed., 2021.
R4. Disaster Management in India: Policy, Issues and Perspectives, Saini, V. K., Sage India, 2021.
R5. Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes, Kelman, I., Oxford University Press, 2022
R6. Disaster Mitigation: Experiences and Reflections, Sahni, P. & Dhameja, A., Prentice Hall of India, 2004.

Web Resources:

1. https://ndma.gov.in – official guidelines, reports, and policy frameworks.
2. https://www.undrr.org – Sendai Framework, global risk reduction strategies.
3. https://www.gdacs.org – real-time disaster alerts
4. https://www.undrr.org – Sendai Framework, global risk reduction strategies.

2598181	**M.Tech., I-SEMESTER** **ESSENCE OF** **INDIAN TRADITIONAL KNOWLEDGE** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(AUDIT COURSE - I)**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSE OUTCOMES:

After completion of the course, student will be able to

CO1. Illustrate traditional knowledge, its nature, characteristics, and scope

CO2. Demonstrate the need for protecting traditional knowledge and its significance in the global economy

CO3. Explain the legal framework and policies related to traditional knowledge protection

CO4. Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology

CO5. Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change, relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

SYLLABUS:

UNIT-I: INTRODUCTION TO TRADITIONAL KNOWLEDGE (06 Periods)

Definition, Nature and characteristics, scope and importance - Kinds of traditional knowledge - Physical and social contexts in which traditional knowledge develop - Historical impact of social change on traditional knowledge systems - Indigenous Knowledge (IK) – Characteristics - traditional knowledge vis-à-vis indigenous knowledge -Traditional knowledge Vs western knowledge, traditional knowledge vis-à-vis formal knowledge

UNIT-II: PROTECTION OF TRADITIONAL KNOWLEDGE (06 Periods)

Need for protecting traditional knowledge - Significance of TK Protection - Value of TK in global economy - Role of Government to harness TK.

UNIT-III: LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE (06 Periods)

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 - Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act) –
The Biological Diversity Act 2002 and Rules 2004 - the protection of traditional knowledge bill, 2016 Geographical Indicators Act 2003.

UNIT-IV: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY (06 Periods)

Systems of traditional knowledge protection - Legal concepts for the protection of traditional knowledge - Certain non-IPR mechanisms of traditional knowledge protection - Patents and traditional knowledge - Strategies to increase protection of traditional knowledge -Global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-V: TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS (06 Periods)

Traditional knowledge and Engineering - Traditional medicine system - TK and Biotechnology - TK in Agriculture - Traditional societies depend on it for their food and healthcare needs - Importance of conservation and sustainable development of environment - Management of biodiversity, Food security of the country and protection of TK

Total Periods: 30

Textbooks:

T1. Introduction to Indian Knowledge System: Concepts and Applications, Mahadevan, B., Bhat Vinayak Rajat, and Nagendra Pavana R.N., PHI Learning Pvt. Ltd., Delhi, 2022 (1st Edition).
T2. Traditional Knowledge System and Technology in India, Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan, 2012 (1st Edition).

Reference Books

R1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi 2006.
R2. On Astronomy in Ancient India, Kak, S.C. Indian Journal of History of Science, 22(3), 1987
R3. Indian Astronomy: A Source Book, Subbarayappa, B.V. and Sarma, K.V. Nehru Centre, Mumbai, 1985.
R4. History of Technology in India, Vol. I, Bag, A.K., Indian National Science Academy, New Delhi, 1997.
R5. Indian Architecture, Acarya, P.K. Munshiram Manoharlal Publishers, New Delhi, 1996.
R6. Public Administration in Ancient India, Banerjea, P. Macmillan, London, 1961.
R7. Indian Knowledge Systems Vol – I & II, Kapoor Kapil, Singh Avadhesh, Indian Institute of Advanced Study, Shimla, H.P., 2022

Web Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/12110600

2512201	M.Tech., II-SEMESTER ADVANCED FOUNDATION ENGINEERING (GEOTECHNICAL ENGINEERING)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Design exploration programs for different sites and interpret data from boring and penetration test for engineering decision

CO2. Apply IS codes to design shallow foundations, proportion footings and rafts based on site data.

CO3. Estimate pile and pile group capacity and settlement, apply IS codes, and field test data for pile design.

CO4. Analyse and Design well foundations for bridges and heavy structures, and interpret codal provisions for safe and sustainable design.

CO5. Propose solutions for foundations on problematic soils and design coffer dams and foundations under uplift conditions.

SYLLABUS:

UNIT- I: SOIL EXPLORATION AND SUBSURFACE INVESTIGATION (10 Periods)

Planning soil exploration - objectives, scope, site reconnaissance, Methods of subsurface exploration - direct (borings, test pits), indirect (geophysical), Boring methods - auger, rotary, wash, percussion, Penetration tests - SPT, CPT, DCPT, SCPT, pressure meter, dilatometer, Sampling techniques - disturbed, undisturbed, representative, Bore log preparation, report writing, data interpretation, Recent trends - digital data logging, remote sensing, AI in site characterization

UNIT- II: SHALLOW FOUNDATIONS AND PERFORMANCE (10 Periods)

Types of shallow foundations - spread footings, rafts, Requirements for satisfactory performance - settlement, bearing capacity, safety, bearing capacity theories - Terzaghi, Meyerhof, IS code methods, Settlement analysis - immediate, consolidation, differential Proportioning foundations using field test data (SPT, plate load), IS codes - IS 6403, IS 1904, IS 2950, Recent trends -performance-based design, sustainability in foundation selection.

UNIT- III: PILE FOUNDATIONS AND DEEP FOUNDATION DESIGN (10 Periods)

Types of piles - driven, bored, under-reamed, Load transfer mechanisms - end bearing, skin friction, Settlement of single piles and pile groups, Negative skin friction, group efficiency, Laterally loaded piles - analysis and design, Pile load tests - static, dynamic, interpretation, Analytical estimation of load-settlement behaviour, Proportioning pile foundations, lateral and uplift capacity, IS codes - IS 2911 series, Recent trends - pile testing technologies, sustainability in deep foundations.

UNIT- IV: WELL FOUNDATIONS AND CODAL PROVISIONS (08 Periods)

Well foundations - types, construction, applications, Elastic theory and ultimate resistance methods, IS and IRC codal provisions for well foundations, Design for vertical, lateral, and uplift loads, Recent trends - monitoring and instrumentation, sustainability in bridge foundations.

UNIT- V: FOUNDATIONS ON PROBLEMATIC SOILS, COFFER DAMS, AND UPLIFT LOADS (10 Periods)

Problematic soils: collapsible, expansive, organic, marine, Foundation solutions: soil improvement, special foundation types, Coffer dams: types, analysis, design, construction, Foundations under uplift loads: design considerations, safety, recent trends - sustainable ground improvement, monitoring technologies

Total Periods: 48

Text books:

T1. Foundation Analysis & Design Bowles, J.E, McGraw-Hill, 1996, 5th Edition,.
T2. Principles of Foundation Engineering, Das, B.M, Cengage Learning, 2023.
T3. Basics of Foundation Design, Fellenius, B.H, Electronic Edition, 2025.

Reference Books:

R1. Foundation Design: Principles and Practices (Pearson), Coduto, D.P, Pearson Education, 2022, 3rd Edition.
R2. Geotechnical Investigation Methods (Taylor & Francis), Hunt, E, CRC Press (Taylor & Francis Group), 2007, 1st Edition.
R3. An Introduction to Modern Techniques in Geotechnical and Foundation Engineering, Kurian, N.P, 2013, 1st Edition.
R4. IS Codes (IS 6403, IS 1904, IS 2950)
R5. IS 2911 (Parts 1- 4)
R6. IS 3955, IRC 78

Web Resources:

1. NPTEL Geotechnical Engineering II
2. NPTEL Foundation Engineering
3. NPTEL Problematic Soils Module
4. IRICEN Pile & Well Foundation Manual

2512202	M.Tech., II-SEMESTER GROUND IMPROVEMENT TECHNIQUES (GEOTECHNICAL ENGINEERING)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1. Identify problematic soils and justify the need for ground improvement, select appropriate ground improvement techniques for various geotechnical challenges.

CO2. Design and recommend mechanical/hydraulic modification techniques for site-specific problems, analyse field and lab data to assess improvement.

CO3. Select and design chemical/thermal modification techniques for problematic soils, evaluate the use of industrial by-products and waste for sustainable ground improvement.

CO4. Analyse and select appropriate reinforcement techniques

CO5. Apply ground improvement methods to real-world projects, evaluate the sustainability and resilience of ground improvement solutions.

SYLLABUS:

UNIT- I: INTRODUCTION TO GROUND IMPROVEMENT (08 Periods)

Situations requiring ground improvement - soft soils, loose sands, expansive/collapsible soils, contaminated sites, Overview of ground improvement methods - mechanical, hydraulic, chemical, thermal, reinforcement, Criteria for selection - soil type, project requirements, sustainability, cost, Recent trends - digital site investigation, sustainability assessment, AI in ground improvement

UNIT- II: MECHANICAL AND HYDRAULIC MODIFICATION (10 Periods)

Mechanical modification - dynamic compaction, impact loading, compaction by blasting, vibro-compaction, Pre-compression, stone columns, sand drains, Hydraulic modification - dewatering systems (well points, deep wells), preloading, vertical drains, electro-kinetic dewatering, Design principles, equipment, monitoring, and quality control, Recent trends - energy-efficient compaction, smart sensors for monitoring.

UNIT- III: CHEMICAL AND THERMAL MODIFICATION (10 Periods)

Chemical modification - admixtures (lime, cement, fly ash, industrial wastes), stabilization mechanisms, Grouting - types (permeation, compaction, jet), materials, applications, Thermal modification - ground freezing and thawing, applications in tunnelling and deep excavations, Environmental impact, sustainability, and regulatory considerations, Recent trends - bio-mediated stabilization, use of recycled materials.

UNIT- IV: SOIL REINFORCEMENT AND GEOSYNTHETICS (10 Periods)

Reinforced earth - basic mechanism, types of reinforcements, Geosynthetics - geotextiles, geogrids, geomembranes, geocells, geo nets, soil nails, Selection criteria, installation, and quality control, Recent trends - smart geo synthetics, recycled materials, digital monitoring, Sustainability and life-cycle assessment.

UNIT- V: APPLICATIONS AND SUSTAINABLE DESIGN IN GROUND IMPROVEMENT (10 Periods)

Applications - shallow foundations on reinforced earth, reinforced earth retaining walls, embankments, walls with reinforced backfill, Analysis and design of shallow foundations on reinforced earth, Road design with Geosynthetics: separation, reinforcement, drainage, Case studies - sustainable ground improvement in infrastructure, Recent trends - performance-based design, monitoring, and maintenance.

Total Periods: 48

Text books:

T1. Engineering Principles of Ground Modification, Haussmann, M.R, Mc Graw-Hill, 1990.
T2. Ground Improvement, Moseley, M.P. & Kirsch, K, CRC Press, 2004, 2nd Edition.
T3. Designing with Geosynthetics (6th Ed.), Koerner, R.M, Xlibris Publishing, 2012, 6th Edition.

Reference Books:

R1. Guidelines for ground improvement - IS 13094:1992
R2. Foundation Design: Principles and Practices, Coduto, D.P, Pearson Education, 2022, 3rd Edition.
R3. Soil and Rock Modification by Chemicals, Bell, F.G, Taylor & Francis, 1st Edition, 1993.
R4. Soil Stabilization Methods and Materials, Makusa, G.P, 2012.
R5. Geotechnical Engineering, Gulati, S.K. & Datta, M, Tata Mc Graw-Hill Education, 2005.

Web Resources:

1. NPTEL Ground Improvement Course
2. ASCE Soil Improvement Book
3. COEP Syllabus PDF
4. GRT Soil Stabilization Techniques
5. Hopkins EP Ground Improvement Methods
6. Science Direct Soil Improvement Book
7. Tab logs Advanced Soil Stabilization
8. Geosynthetics Society Library
9. NPTEL Reinforced Earth Structures
10. UN SDGs

2512203	M.Tech., II-SEMESTER EARTH RETAINING STRUCTURES (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-III)	L	T	P	C
		3	0	0	3

Pre-Requisites: Engineering Geotechnics

Course Outcomes:

On successful completion of the course, the student will be able to

CO1. Calculate earth pressures for various backfill conditions and apply earth pressure theories to design retaining structures.

CO2. Proportion retaining walls for stability and serviceability, and design mechanically stabilized earth walls using modern methods.

CO3. Calculate earth pressures and moments in sheet pile walls, design anchored bulkheads, and determine anchor spacing.

CO4. Calculate stresses and design support systems for tunnels, apply arching theory to soil and rock excavation.

CO5. Design bracing systems for excavations, predict and mitigate bottom heave in soft soil cuts.

SYLLABUS:

UNIT- I: EARTH PRESSURE THEORIES AND BACKFILL EFFECTS (10 Periods)

Rankine and Coulomb theories - assumptions, derivations, Active, passive, and pressure at rest, effects of concentrated and uniform surcharge, Earth pressure in stratified, saturated, and partially saturated backfills, Influence of wall friction and adhesion, Recent advances - numerical modelling of earth pressures, seismic effects

UNIT- II: RETAINING WALLS AND STABILITY ANALYSIS (10 Periods)

Types and functions of retaining walls, Stability analysis - overturning, sliding, bearing capacity, mechanically stabilized retaining walls (MSRW) - materials, design principles, Drainage behind retaining walls, Recent trends - use of geo synthetics, performance-based design.

UNIT- III: SHEET PILE WALLS AND BULKHEADS (08 Periods)

Sheet pile walls - free earth and fixed earth systems, Bulkheads - classification, equivalent beam method, Anchorage systems - design of anchors, anchor plates, Spacing and load distribution in bulkheads, Recent developments - composite sheet piles, corrosion-resistant materials.

UNIT- IV: TUNNEL AND CONDUIT STRESS ANALYSIS, ARCHING, AND OPEN CUTS (10 Periods)

Stress distribution around tunnels - elastic and elasto-plastic analysis, Types of conduits and load considerations, Arching in soils - theory and applications, Open-cut excavation - earth pressure and support design, recent trends - numerical modelling, instrumentation and monitoring

UNIT- V: BRACED EXCAVATIONS AND STABILITY OF CUTS (10 Periods)

Earth pressure theories for braced cuts, Design of struts and braces, Heave mechanisms and prediction in soft clays, Stability analysis of vertical and inclined cuts, Recent advances - instrumentation, real-time monitoring.

Total Periods: 48

Text books:

T1. Designing with Geosynthetics, Koerner, R.M, Xlibris Publishing, 6th Edition, 2012.
T2. Foundation Analysis and Design, Bowles, J.E, McGraw-Hill, 5th Edition, 1996.

T3. Principles of Geotechnical Engineering, Das, B.M, Cengage Learning, 9th Edition, 2018.

Reference Books:

R1. Design of Sheet Pile Walls, Gilbert Gedeon
R2. Underground Excavations in Rocks, Hoek, E. & Brown, E.T.
R3. Rock Mechanics and Design of Structures in Rocks, Obert, L. & Duvall, W.I.
R4. Rock Mass Classification, Singh, B. & Goel, R.K.,
R5. IS 456, IS 8002, IS 2911

Web Resources:

1. NPTEL Earth Pressure Theories
2. NPTEL Rock Mechanics and Tunnelling
3. Springer Rock Mechanics
4. NPTEL Braced Excavations

2512204	M.Tech., II-SEMESTER DESIGN OF UNDERGROUND EXCAVATIONS (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-III)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1. Plan exploration for underground projects and select appropriate investigation methods, use stereographic projection for orientation analysis and preliminary design.

CO2. Calculate stress distribution for different tunnel geometries and in-situ conditions, and apply Greenspan and Daemen's theories in tunnel design.

CO3. Use RMR, Q-system, and other classification systems for tunnel support design, and estimate modulus of deformation using field and lab tests.

CO4. Develop ground response and support reaction curves for tunnel design, design, and select appropriate support systems for different ground conditions.

CO5. Select and implement appropriate instrumentation for underground projects, analyse monitoring data to ensure safety, and optimize construction methods.

SYLLABUS:

UNIT- I: INTRODUCTION, PLANNING, AND STEREOGRAPHIC METHOD

(10 Periods)

Types and applications of underground structures (tunnels, caverns, metros, storage), Planning and exploration - site investigation, data collection, risk assessment, Stereographic projection - principles, plotting planes and lines, kinematic analysis, Application in underground excavation design (orientation of joints, wedge analysis), Recent trends - digital mapping, GIS integration, and sustainability in underground planning.

UNIT- II: STRESS DISTRIBUTION AND TUNNEL DESIGN PRINCIPLES

(10 Periods)

Elastic stress distribution-circular, elliptical, and non-circular tunnels, Stress distribution under different in-situ stress conditions, Greenspan method for multiple openings, Openings in laminated rocks - anisotropy effects, Elasto-plastic analysis of tunnels, Daemen's theory, Recent trends - numerical modelling (FEM/BEM), digital twin concepts.

UNIT- III: ROCK MASS CLASSIFICATION, GROUND CONDITIONS, AND EMPIRICAL METHODS **(10 Periods)**

Rock mass classification: RMR, Q-system, GSI, RSR (application and limitations), ground conditions - squeezing, swelling, water inflow, time-dependent behaviour, Empirical methods for tunnel support and design, estimation of elastic modulus - uniaxial/plate/radial jacking, Goodman jacking, NATM and NTM - principles, observational method, convergence-confinement, Construction dewatering - methods and sustainability, Recent trends - AI/ML in rock mass classification, digital monitoring.

UNIT- IV: TUNNEL SUPPORT INTERACTION AND SUPPORT SYSTEM DESIGN

(10 Periods)

Rock mass-tunnel support interaction - ground response and support reaction curves, Ladanyi's elasto-plastic analysis, Design of support systems - concrete/shotcrete linings, steel sets, rock bolts, anchors, Combined support systems and load-carrying capacity estimation, Recent trends - smart support systems, fiber-reinforced shotcrete, digital monitoring.

UNIT- V: IN-SITU STRESS MEASUREMENT, INSTRUMENTATION, AND MONITORING **(10 Periods)**

In-situ stress measurement - flat jack, hydraulic fracturing, over coring, deformation and load measurement - USBM drill hole gauge, extensometers, load/pressure cells, instrumentation and monitoring - principles, planning, data interpretation, case studies - instrumentation in metro, hydro, and storage tunnels, recent trends - real-time monitoring, IOT, cloud-based data analytics, sustainability in monitoring.

Total Periods: 50

Text books:

T1. Introduction to Rock Mechanics, Wiley Goodman, R.E, John Wiley & Sons, 2nd Edition, 1989.
T2. Underground Structures: Design and Instrumentation, Sinha, R.S, Elsevier, 1989.
T3. Rock Mechanics and Rock Engineering, Aydan, Ö, CRC Press, 2019.

Reference Books:

R1. Underground Excavations in Rock, Hoek, E. & Brown, E.T, CRC Press.
R2. Engineering Rock Mechanics, Hudson, J.A. & Harrison, J.P., Elsevier.
R3. Fundamentals of Rock Mechanics, Jaeger, J.C., Cook, N.G.W., & Zimmerman, R.W, Wiley.
R4. Design Methodology in Rock Engineering, Bieniawski, Z.T, CRC Press, 2020.
R5. Rock Mechanics for Underground Mining, Brady, B.H.G, Springer.
R6. Underground Structures: Design and Instrumentation, Sinha, R.S, Elsevier.

Web Resources:

1. NPTEL Geo techniques of Dams, Tunnels and Underground Spaces
2. NPTEL Rock Mechanics and Tunneling
3. Springer Rock Mechanics and Rock Engineering Journal
4. Rock Mass Classification (Rocscience)
5. Science Direct – Rock Mass Classification
6. Instrumentation and Monitoring in Tunnels (Encardio)
7. Tunnel India Blog: Instrumentation and Monitoring
8. NPTEL Geotechniques of Dams, Tunnels and Underground Spaces
9. SCIRP: Monitoring Instrumentation in Underground Structures

		L	T	P	C
2512205	**M.Tech., II-SEMESTER** **PHYSICAL AND CONSTITUTIVE MODELLING IN GEOMECHANICS** (GEOTECHNICAL ENGINEERING) **(PROGRAM ELECTIVE-III)**	**3**	**0**	**0**	**3**

Pre-Requisites: Engineering Mechanics

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the role and importance of constitutive modelling in understanding soil behaviour through laboratory testing.

CO2. Apply the concepts of linear, quasi-linear, and anisotropic elasticity to describe soil response under different loading conditions.

CO3. Formulate and interpret plasticity models, yield criteria, and flow rules for rate-independent materials.

CO4. Analyse and compare different plasticity models such as Mohr–Coulomb, Drucker–Prager and cap models in predicting failure behaviour.

CO5. Interpret the critical state concept and simulate soil behaviour using Cam Clay models for single element tests.

SYLLABUS:

UNIT- I: ROLE OF CONSTITUTIVE MODELING **(12 Periods)**

Importance of laboratory testing with relation to constitutive modelling, Elasticity: linear, quasi linear, anisotropic

UNIT- II: PLASTICITY BASICS **(10 Periods)**

Yield criteria, flow rule, plastic potential, hardening / softening, Rate Independent Plasticity - Mohr-coulomb, nonlinear failure criteria, Drucker Prager, and cap models

UNIT- III: CRITICAL SOIL MECHANICS **(08 Periods)**

critical state concept, cam clay models, simulation of single element test using cam clay

UNIT- IV: CONSOLIDATION **(08 Periods)**

Drained and undrained triaxial test, Stress Dilatancy theory

UNIT- V: Work hardening plasticity theory **(07 Periods)**

Formulation and implementation, Applications of elasto-plastic models, Special Topics: hypo elasticity-plasticity, disturbed state concept.

Total Periods: 45

Text books:

T1. Constitutive Modelling of Soils and Rocks, Hicher and Shao, JohnWiley.2008
T2. Constitutive Laws for Engineering Materials with Emphasis on Geologic Materials, C.S. Desai and H.J. Siriwardane, Prentice-Hall, Inc., New Jersey. 1984
T3. Finite Element Analysis in Geotechnical Engineering Theory and Application, David M Pott sand Lidija Zdravkovic, Thomas Telford. 1999

Reference Books:

R1. Mechanics of Materials and Interfaces: The Disturbed State Concept, CRC Press LLC. 2000, S. Desai,
R2. Mechanics of Geo material Interfaces, Elsevier, A. P. S. Selvadurai, M. J. Boulon

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview
2. https://nptel.ac.in/courses/108104139
3. https://nptel.ac.in/courses/108106172
4. https://nptel.ac.in/courses/117106108

2512206	M.Tech., II-SEMESTER FOUNDATIONS ON EXPANSIVE SOILS (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the origin, physical properties and mineralogical composition of expansive

CO2. Identify the expansive soils and assess field conditions that lead to soil swelling and its consequences

CO3. Evaluate and apply different soil techniques such as over excavation and pre wetting methods

CO4. Design appropriate shallow foundation systems

CO5. Design and assess deep foundation systems including piers and grade beams for expansive soil conditions

SYLLABUS:

UNIT- I: GENERAL PRINCIPLES (12 Periods)

Origin of expansive soils – Physical properties of expansive soils – Mineralogical composition -Identification of expansive soils – Field conditions that favour swelling- Consequences of swelling.

UNIT- II: SOIL TREATMENT ANDMOISTURE CONTROL (08 Periods)

Over excavation and Replacement, Pre-wetting Method, Chemical Admixtures, Moisture Control Alternatives

UNIT- III: DESIGN METHODS FOR SHALLOW FOUNDATIONS (10 Periods)

Spread Footing Foundations, Stiffened Slab Foundations, Remedial Measures for Shallow Foundations

UNIT- IV: DESIGN METHODS WITH DEEP FOUNDATIONS (08 Periods)

Pier and Grade Beam Foundation, Patented Piers, Deep Foundation Design Examples, Remedial Measures for Deep Foundations

UNIT- V: LATERAL PRESSURE ON EARTH RETAINING STRUCTUR (07 Periods)

Computation of Lateral Pressure from Expansive Soils, Testing for Measuring Lateral Swelling Pressure, Reduction of Lateral Swelling Pressure, Design for Lateral Earth Pressure

Total Periods: 45

Text books:

T1. Expansive Soils–Problems and Practice in Foundation and Pavement Engineering, John D Nelson and Debora J Miller, John Wiley &Sons, INC.

T2. Expansive Soils – Problems and Remedies, Rama Chandra Phani Kumar and Sana Suri., LAP Lambert Academic Publishing.

Reference Books:

R1. A Review of Engineering Experiences with Expansive Soils in High way Sub-grades D. R. Snethen., Federal Highway Administration, Washington DC.

R2. Foundations on Expansive Soils, F.H. Chen, Elsevier Scientific Publishing Company, New York.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview

2. https://nptel.ac.in/courses/108104139

2512207	M.Tech. GTE, II SEMESTER PAVEMENT ANALYSIS AND DESIGN (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Pre-Requisites: Transportation Engineering

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Evaluate modern pavement materials, sustainable technologies, and pavement management principles

CO2. Analyse stress-strain-deflection behaviour in flexible pavements using advanced computational methods

CO3. Design flexible pavements using mechanistic-empirical approaches for highways and airports

CO4. Analyse rigid pavements considering temperature gradients, joint behavior, and environmental factors

CO5. Design rigid pavement systems and develop pavement rehabilitation and maintenance strategies

SYLLABUS:

UNIT-I: MODERN PAVEMENT SYSTEMS AND MATERIALS (9 Periods)

Introduction to pavement engineering, historical development - Types of pavements: flexible, rigid, composite, perpetual pavements - Component parts and their functions - Advanced pavement materials - warm mix asphalt, polymer modified bitumen, recycled materials - Sustainable pavement technologies - pervious concrete, cool pavements, solar pavements - Pavement management systems - condition assessment, performance prediction - Design factors: traffic, environment, materials, drainage - Highway and airport pavement requirements and specifications - Smart pavements and IoT integration.

UNIT-II: FLEXIBLE PAVEMENT ANALYSIS (9 Periods)

Stresses and strains in elastic layered systems - Boussinesq's theory for homogeneous half-space - Burmister's two-layer and three-layer elastic solutions - multi-layer elastic analysis using computational tools - Wheel load configurations and stress distribution - Equivalent single wheel load (ESWL) and equivalent single axle load (ESAL) - Dynamic loading and viscoelastic analysis - Finite element analysis of flexible pavements - Fatigue and rutting criteria - Performance-based specifications

UNIT-III: FLEXIBLE PAVEMENT DESIGN (9 Periods)

Design philosophies: empirical, semi-empirical, mechanistic, mechanistic-empirical - AASHTO design procedure (1993) - design inputs, reliability, serviceability - Mechanistic-Empirical Pavement Design Guide (MEPDG/AASHTO Ware) - Asphalt Institute method - thickness design, layer coefficients - Shell pavement design method - IRC methods: IRC 37-2018 for highway pavements - Perpetual pavement design concepts - Airport flexible pavement design - FAA methodology - Design for heavy haul roads and industrial pavements - Life cycle cost analysis and sustainability assessment

UNIT-IV: RIGID PAVEMENT ANALYSIS (9 Periods)

Types of stresses in rigid pavements: traffic, temperature, moisture - Westergaard's equations: edge loading, corner loading, interior loading - Modified Westergaard equations and finite element validation - Temperature gradients and warping stresses - Frictional stresses at pavement-base interface - Combined stress analysis - 3D finite element modeling of rigid pavements - Fracture

mechanics approach to cracking - Load transfer mechanisms at joints - Nonlinear analysis for cracked pavements

UNIT-V: RIGID PAVEMENT DESIGN AND REHABILITATION (9 Periods)

IRC 58-2015 design procedure for highway rigid pavements - FAA design procedure for airport rigid pavements - Design of joints: contraction, expansion, construction, warping joints - Joint spacing and layout - Reinforcement design: distributed steel, structural reinforcement - Dowel bar and tie bar design - Continuously reinforced concrete pavement (CRCP) design - Ultra-thin white topping and thin bonded overlays - Pavement rehabilitation strategies - overlays, recycling, reconstruction - Pavement evaluation and condition surveys - Maintenance management and preservation techniques

Total Periods: 45

Text books:

T1. Pavement Analysis and Design Huang, Yang H**,** Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2nd Edition, ISBN: 978-0131424739, 2004.

T2. Principles of Pavement Design, Yoder, E.J. and Witczak, M.W. New York, USA: John Wiley & Sons, 2nd Edition, ISBN: 978-0471976868, 1975.

T3. Pavement Engineering: Principles and Practice, Mallick, R.B. and El-Korchi, T. Boca Raton, FL, USA: CRC Press, Taylor & Francis Group, 3rd Edition, ISBN: 978-1498738934, 2017

Reference Books:

R1. Indian Roads Congress (2018). Guidelines for the Design of Flexible Pavements, IRC:37-2018 (4th Revision). New Delhi, India: Indian Roads Congress.

R2. Indian Roads Congress (2015). Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, IRC:58-2015*(*3rd Revision*).* New Delhi, India: Indian Roads Congress.

R3. Federal Aviation Administration (2021). Airport Pavement Design and Evaluation*,* Advisory Circular AC 150/5320-6F. Washington, DC, USA: U.S. Department of Transportation.

R4. Principles of Pavement Engineering, Thom, Nicholas, London, UK: ICE Publishing, Thomas Telford Ltd., 2014, 2nd Edition. ISBN: 978-0727757326

R5. Croney, D. and Croney, P.**,** Design and Performance of Road Pavements, New York, USA: McGraw-Hill Professional, 1998, 3rd Edition. ISBN: 978-0077079451

R6. American Association of State Highway and Transportation Officials (AASHTO). Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, 2015, 2nd Edition. Washington, DC, USA: AASHTO.

R7. Modern Pavement Management, Haas, R., Hudson, W.R., and Zaniewski, J.P., Malabar, FL, USA: Krieger Publishing Company, 1994. ISBN: 978-0894648533

Web Resources:

1. https://archive.nptel.ac.in/courses/105/105/105105115/ (NPTEL - Highway Engineering)
2. https://onlinecourses.nptel.ac.in/noc24_ce65/preview (Transportation Engineering)
3. https://archive.nptel.ac.in/courses/105/106/105106120/ (Pavement Design)
4. MIT Open Course Ware - Pavement Engineering
5. https://www.asphaltinstitute.org/engineering/mix-design-methods/
6. https://archive.nptel.ac.in/courses/105/101/105101087/ (NPTEL - Rigid Pavement)
7. ANSYS/ABAQUS Tutorial Videos for Pavement Analysis
8. https://www.concrete.org/education/onlinelearning.aspx
9. https://www.gti.tech/whitetopping-resources/

		L	T	P	C
2512208	**M.Tech., II-SEMESTER** **SOIL DYNAMICS AND MACHINE FOUNDATIONS** (GEOTECHNICAL ENGINEERING) **(PROGRAM ELECTIVE-IV)**	**3**	**0**	**0**	**3**

Pre-Requisites: Engineering Mechanics

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the principles of vibrations and evaluate the response of single, two, and multiple degree of freedom systems.

CO2. Analyse the propagation and attenuation of seismic waves in soils and interpret dynamic soil behavior under cyclic loading.

CO3. Assess the liquefaction potential of soils through experimental methods and empirical correlations

CO4. Determine dynamic elastic constants of soils using laboratory and field-testing techniques such as block resonance, cyclic plate load, and wave propagation tests.

SYLLABUS:

UNIT- I: FUNDAMENTALS OF VIBRATIONS (12 Periods)

Single, two and multiple degree of freedom systems, vibration isolation, vibration absorbers, Frequency dependent excitation, Logarithmic decrement, Determination of viscous damping, Systems with Two and Multiple degrees of freedom, vibration measuring instruments

UNIT- II: WAVE PROPOGATION AND DYNAMIC SOIL PROPERTIES (08 Periods)

Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behavior of cyclically loaded soils, Dynamic soil properties - Laboratory and field-testing techniques, Elastic constants of soils, Correlations for shear modulus and damping ratio in sands and clays.

UNIT- III: LIQUEFACTION OF SOILS (10 Periods)

Liquefaction mechanism, factors affecting liquefaction, studies by dynamic tri-axial testing, oscillatory shear box, shake table and blast tests, assessment of liquefaction potential.

UNIT- IV: DYNAMIC ELASTIC CONSTANTS OF SOIL (08 Periods)

Determination of dynamic elastic constants, various methods including block resonance tests, cyclic plate load tests, wave propagation tests, oscillatory shear box test.

UNIT- V: MACHINE FOUNDATIONS (07 Periods)

Design criteria for machine foundations; Elastic homogeneous half space and lumped parameter solutions, analysis and design of foundations for reciprocating and impact type machines, turbines, effect of machine foundation on adjoining structures.

Total Periods: 45

Text books:

T1. Fundamentals of Soil Dynamics, Das, B.M., Elsevier, 1983.
T2. Geotechnical Earth quake Engineering, Steven Kramer, Pearson, 2008.
T3. Soil Dynamics, Prakash, S., McGraw Hill, 1981.

Reference Books:

R1. Fundamentals of Soil Dynamics, Das, B.M, Elsevier, 1983.
R2. Geotechnical Earth quake Engineering, Steven Kramer, Pearson, 2008
R3. Soil Dynamics, Prakash, S, Mc Graw Hill, 1981.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview
2. https://nptel.ac.in/courses/108104139
3. https://nptel.ac.in/courses/108106172
4. https://nptel.ac.in/courses/117106108

2512251	M.Tech., II-SEMESTER SUB SOIL EXPLORATION LAB (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	4	2

Pre-Requisite: Geotechnical Engineering

COURSE OUTCOMES:

CO1. Analyse the soil strata and sampling using auger boring
CO2. Conduct and interpret standard penetration test
CO3. Perform plate load test and evaluate the soil bearing capacity
CO4. Execute the California bearing ratio test
CO5. Able to apply appropriate Tools and Techniques to understand and analyse the problems following professional ethics with focus on societal and environmental aspects.
CO6. Work as a team and communicate results in an effective way.
CO7. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

List of Experiments:

1. Auger Boring
2. Standard Penetration Test
3. Plate Load Test
4. Field CBR Test
5. Pile Load Test
6. Geo physical Exploration Tests

Text books:

T1. S. Mittal and JP Shukla, Soil Testing for Engineers, Khanna Publishers, New Delhi, 2008.

Reference Books:

R1. Compendium of Indian Standards on Soil Engineering: Part–1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.

2512252	M.Tech. II-SEMESTER GEOTECHNICAL ENGINEERING MODELLING LAB (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	4	2

Pre-Requisites: NIL

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Design and analyse retaining wall systems (cantilever, anchored, and non-anchored) and evaluate their stability under various loading conditions.

CO2. Perform slope stability analysis using limit equilibrium and finite element methods, and design appropriate stabilization measures for unstable slopes.

CO3. Design shallow and deep foundation systems including spread footings, pile foundations, and pile groups, considering bearing capacity, settlement, and consolidation characteristics using analytical and numerical methods.

CO4. Able to apply appropriate Tools and Techniques to understand and analyse the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

SYLLABUS:

1. Design of a cantilever wall
2. Design of a non-anchored retaining wall
3. Design of an anchored retaining wall
4. Slope stability analysis
5. Design of a geometry of a spread footing
6. Settlement of a spread footing
7. Analysis of a consolidation under embankment
8. Analysis of vertical load-bearing capacity of a single pile
9. Analysis of a single pile settlement
10. Analysis of horizontal bearing capacity of a single pile
11. Analysis of vertical load bearing capacity and settlement of a pile group
12. Stabilizing a slope using anti-slide piles
13. Settlement of a circular silo foundation
14. Numerical solution to a sheeting wall structure
15. Slope stability assessment (FEM)

Textbooks:

T1. Principles of Foundation Engineering, Braja M. Das, 9th Edition, Cengage Learning, 2021.
T2. Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, Murthy, V.N.S , CRC Press, 2019.
T3. Foundation Analysis and Design, 5th Edition, McGraw-Hill Education, Bowles, J.E. 2020.
T4. Soil Mechanics and Foundations, Budhu, M, 4th Edition, John Wiley & Sons, 2020.

Reference Books:

R1. Pile Foundation Analysis and Design, Poulos, H.G. and Davis, E.H., John Wiley & Sons 2020
R2. Pile Design and Construction Practice, Tomlinson, M.J. and Woodward, J, 6th Edition, CRC Press, 2014.
R3. Soil Mechanics in Engineering Practice, Terzaghi, K., Peck, R.B., and Mesri, G, 3rd Edition, John Wiley & Sons, 1996.

R4. Geotechnical Engineering: Principles and Practices Coduto, D.P., Yeung, M.R., and Kitch, W.A, 2nd Edition, Pearson, 2016.
R5. Soil Strength and Slope Stability, Duncan, J.M. Wright, S.G., and Brandon, T.L, 2nd Edition, John Wiley & Sons, 2014.
R6. Earth Pressures and Retaining Walls, Huntington, W.C. John Wiley & Sons, 1957.
R7. Craig's Soil Mechanics, Craig, R.F, 8th Edition, CRC Press, 2012.
R8. Geotechnical Engineering: Foundation Design, Cernica, J.N, John Wiley & Sons, 1995.
R9. Soil Mechanics and Foundation Engineering, Purushothamaraj, P, Pearson Education India, 2012.

Web Resources:

1. PLAXIS - https://www.bentley.com/software/plaxis/
2. GEO5 - https://www.finesoftware.eu/geotechnical-software/
3. SLOPE/W (Geo Studio) - https://www.geoslope.com/products/slope-w
4. ROCSCIENCE - https://www.rocscience.com/
5. MIDAS GTS NX - https://www.midasgeotech.com

2512253	M.Tech., II-SEMESTER COMPREHENSIVE VIVA VOCE (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	0	2

Pre-Requisites: All Courses

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Demonstrate comprehensive understanding of core concepts learned throughout the program.

CO2. Apply theoretical knowledge to analyze and solve discipline-specific problems.

CO3. Communicate technical ideas, concepts, and project outcomes clearly and effectively during oral examination.

CO4. Integrate knowledge from various subjects to justify solutions and decisions.

CO5. Exhibit critical thinking, professional ethics, and confidence while responding to technical and situational questions.

		L	T	P	C
2598281	**M.Tech., II-SEMESTER** **QUANTUM TECHNOLOGIES AND APPLICATIONS** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(MANDATORY COURSE-II)**	**2**	**0**	**0**	**2**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Demonstrate the basic principles and technological importance of quantum physics.

CO2. Explain the basic concepts of qubits, quantum states, entanglement, and differences between classical and quantum information systems..

CO3. Analyze the key challenges and requirements in developing stable and scalable quantum hardware systems.

CO4. Explain the basic concepts of quantum communication and computing, including QKD, quantum parallelism, and related challenges.

CO5. Demonstrate the major applications, industry developments, and future opportunities of quantum technologies along with their societal and practical challenges.

SYLLABUS:

UNIT-I: FOUNDATIONS OF QUANTUM THEORY AND TECHNOLOGIES (05 Periods)

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty, Wave-particle duality. Quantum states and measurement; the role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic relevance of quantum technologies.

Overview of major domains: Computing, Communication, Sensing. Global quantum initiatives: India's National Quantum Mission, EU Quantum Flagship, USA, China.

UNIT-II: CONCEPTUAL STRUCTURE OF QUANTUM INFORMATION (07 Periods)

Qubits: qualitative understanding using spin and polarization. Classical bits vs quantum bits: distinctions and implications. Quantum systems (non-engineering perspective): trapped ions, superconducting qubits, photonics. Coherence and decoherence mechanisms. Abstract notions: quantum states, measurement operators, Hilbert space—interpretation without mathematics. Entanglement and non-locality as foundational resources. Quantum vs classical information principles; philosophical considerations.

UNIT-III: BUILDING A QUANTUM COMPUTER – CHALLENGES AND REQUIREMENTS (06 Periods)

Conceptual prerequisites for functional quantum hardware. Fragility of quantum states: decoherence, noise, stability issues. Requirements: isolation, error resilience, scalability, control. Why maintaining entanglement is difficult; theoretical necessity of quantum error correction. Comparative overview of hardware platforms (superconducting circuits, trapped ions, photonics).Current progress vs scientific constraints; conceptual view of quantum software's role.

UNIT-IV: QUANTUM COMMUNICATION AND COMPUTING (06 Periods)

Quantum vs classical communication paradigms. Essentials of Quantum Key Distribution (QKD) and its security rationale. Entanglement- enabled communication protocols. Concept of the Quantum Internet and secure global networking. Introduction to quantum computing and quantum

parallelism.
Conceptual comparison of classical and quantum gate operations. Challenges: decoherence, noise, and the necessity of error correction frameworks.

UNIT-V: APPLICATIONS, INDUSTRY, AND FUTURE DIRECTIONS (06 Periods)

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India's strategic opportunity in the global quantum ecosystem.

Total Periods: 30

Textbooks:

T1. Quantum Computation and Quantum Information, Nielsen & Chuang, Cambridge University Press, 2010.
T2. Quantum Computing: A Gentle Introduction, Rieffel & Polak, MIT Press, 2011.
T3. Quantum Computing for Everyone, Chris Bernhardt, MIT Press, 2019.

Reference Books:

R1. Quantum Computing Explained, David McMahon, Wiley, 2008.
R2. An Introduction to Quantum Computing, Kaye, Laflamme, Mosca, OUP, 2007.
R3. Quantum Computing Since Democritus, Scott Aaronson, CUP, 2013.
R4. Quantum Mechanics: The Theoretical Minimum, Susskind & Friedman, Basic Books, 2014.
R5. Quantum Enigma, Rosenblum & Kuttner, OUP, 2011.
R6. Principles of Quantum Computation and Information, Benenti et al., World Scientific, 2004.
R7. DST India and MeitY: Official Quantum Mission Reports, 2020 onwards.
R8. Quantum Flagship EU: Roadmaps and Strategy Documents.

Online Learning Resources

1. IBM Quantum Experience & Qiskit Textbook Coursera – Quantum Mechanics and Quantum Computation (UC Berkeley) edX – Quantum Internet & Quantum Computers
2. YouTube – Quantum Computing for the Determined (Michael Nielsen)

25HS201	M.Tech., II-SEMESTER PEDAGOGY STUDIES (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-II)	L	T	P	C
		2	0	0	0

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Apply pedagogy, learning theories, and technology to design learner-centered education.

CO2. Design and implement effective lesson plans and curriculum using appropriate teaching strategies and technology tools to enhance the teaching–learning process.

CO3. Analyze and apply instructional design models, emerging e-learning trends, and ICT tools to design and implement effective technology-integrated teaching–learning systems.

CO4. Apply pedagogical analysis and appropriate assessment methods, including technology-based tools and reflective practices, to improve teaching–learning effectiveness.

CO5. Apply pedagogical analysis and appropriate assessment methods, including technology-based tools and reflective practices, to improve teaching–learning effectiveness.

SYLLABUS:

UNIT-I: FOUNDATIONS OF PEDAGOGY (05 Periods)

Introduction to pedagogy and its importance in education - Historical and philosophical foundations of pedagogy - Theories of learning and teaching (behaviorist, cognitive, constructivist) - Role of pedagogy in shaping educational practices - Role of technology in modern pedagogy (ICT, e-learning, blended learning)

UNIT-II: TEACHING-LEARNING PROCESSES (06 Periods)

Understanding the teaching-learning process - Lesson planning and curriculum design - Strategies for effective teaching and learning (expository, collaborative, experiential) - Use of technology to enhance teaching-learning processes (multimedia, simulations, gamification)

UNIT-III: TECHNOLOGY INTEGRATION IN EDUCATION (07 Periods)

Educational technology and system design - Instructional design models (ADDIE, ASSURE, Dick and Carey Model) - Emerging trends in e-learning (social learning, MOOCs, mobile learning) - ICT tools for teaching and learning (Learning Management Systems, online resources)

UNIT-IV: PEDAGOGY AND ASSESSMENT (06 Periods)

Pedagogy, pedagogical analysis, and assessment - Types of assessment (placement, formative, diagnostic, summative) - Technology-based assessment tools (online quizzes, polls, discussions) - Rubrics for self and peer evaluation- Reflective Practices

UNIT-V: CONTEMPORARY ISSUES AND TRENDS (06 Periods)

Inclusive education and technology (assistive technology, accessibility) - Change management and innovation in education - Quality assurance and evaluation in education (TQM, Six Sigma) - Future trends in pedagogy and technology (AI, AR, VR in education) - Personalized learning and adaptive teaching

Total Periods: 30

Text Books:

T1. Essays on Pedagogy, Alexander, R. J., Routledge, 2008.
T2. The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach, Shulman, L. S., Jossey-Bass, 2004

Reference Books:

R1. Teaching for the Future: Effective Teacher Education and Pedagogical Practices. OECD Publishing., 2021
R2. System Change in Education: Sustainability and Impact, Fullan, M., & Edwards, M, Routledge, 2022.
R3. Great Teaching Toolkit: Evidence Review, Coe, R., Rauch, C., Kime, S., & Singleton, D., Evidence Based Education., 2020
R4. The Struggle for the Soul of Teacher Education, Zeichner, K. M., Routledge, 2024
R5. UNESCO. Global Education Monitoring Report: Pedagogy, Teachers and Learning. UNESCO Publishing, 2024
R6. Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement, Hattie, J., Routledge., 2009
R7. Teacher Education Around the World: What Can We Learn from International Practice?, Darling-Hammond, L., Routledge, 2007

Online Resources:

1. UNESCO Education Resources – https://www.unesco.org/education
2. OECD Education and Skills – https://www.oecd.org/education
3. ERIC (Education Resources Information Center) – https://eric.ed.gov (peer-reviewed papers, reports).
4. World Bank Education – https://www.worldbank.org/en/topic/education (research reports on teacher development in developing countries).
5. NPTEL/SWAYAM MOOCs – Teacher education and pedagogy-focused courses.
6. Google Scholar Alerts – set alerts for "pedagogical practices", "teacher education", "curriculum research" for the latest academic papers.

		L	T	P	C
25HS202	**M.Tech., II-SEMESTER** **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(AUDIT COURSE-II)**	**2**	**0**	**0**	**0**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Practice self-awareness and personal effectiveness by analyzing strengths, weaknesses, opportunities, and challenges (SWOC), setting SMART goals, and practicing reflection, journaling, and self-care strategies.

CO2. Evince emotional intelligence by developing self-awareness, self-regulation, motivation, communication, interpersonal, and conflict-resolution skills for personal and professional effectiveness.

CO3. Exhibit a positive mindset, resilience, and emotional well-being by cultivating growth-oriented thinking, gratitude, mindfulness, and strategies to overcome negative thoughts and behaviors.

CO4. Enhance personal and professional effectiveness by developing verbal, non-verbal, and presentation skills, while building confidence and competence in public speaking.

CO5. Demonstrate leadership capabilities by understanding styles and qualities, enhancing teamwork, collaboration, and problem-solving skills for effective team management.

SYLLABUS:

UNIT-I: SELF-AWARENESS AND PERSONAL GROWTH (06 Periods)

Understanding personality and its development- Identifying strengths, weaknesses, opportunities, and challenges (SWOC analysis)- Setting personal and professional goals- Practicing Self-Reflection and Journaling

(Activities: Personality assessments, self reflection exercises, group discussions, SWOC analysis worksheet, Action Plan, SMART goal activities, Reflective journaling, Self-care Planning)

UNIT-II: EMOTIONAL INTELLIGENCE AND INTERPERSONAL SKILLS (06 Periods)

Understanding emotional intelligence and its importance - Developing self-awareness, self-regulation, and motivation - Building effective communication and interpersonal skills - Conflict resolution and negotiation strategies.

(Activities: Emotional Intelligence Quiz, Self-Reflection exercises, feedback sessions, mindfulness exercises, Positive self-talk, Active Listening exercises, conflict-resolution Role-play, Case studies & Group activities)

UNIT-III: POSITIVE THINKING AND ATTITUDE (06 Periods)

Understanding the power of positive thinking- Developing a growth mindset and resilience - Practicing gratitude and mindfulness- Overcoming negative thoughts and behaviors

(Activities on positive thinking, growth mindset, mindfulness and self-care plan for overcoming negative thoughts)

UNIT-IV: EFFECTIVE COMMUNICATION AND PRESENTATION SKILLS (06 Periods)

Understanding the importance of effective communication- Developing verbal and non-verbal communication skills- Preparing and delivering effective presentations- Building confidence and public speaking skills

(Activities: Group discussions, Case studies, Role-Play, Non-verbal communication exercises, Practice presentations, Peer feedback, Public speaking exercises, Storytelling, Debates)

UNIT-V: LEADERSHIP AND TEAMWORK (06 Periods)

Understanding leadership styles and qualities - Developing leadership skills and qualities- Building effective teams and teamwork strategies- Practicing collaboration and problem-solving

(Activities: Case studies, Group discussions, Debates, Leadership role-playing, team building activities, Group projects, Collaborative problem-solving exercies, feedback sessions)

Total Periods: 30

Text Books:

T1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ, Bantam Books, 2017.

T2. Stephen R. Covey, The 7 Habits of Highly Effective People, Simon & Schuster, 2020

Reference Books:

R1. Dale Carnegie, How to Win Friends and Influence People, Simon & Schuster, 2020.

R2. Brian Tracy, Goals!: How to Get Everything You Want Faster Than You Ever Thought Possible, Berrett-Koehler Publishers, 2021.

R3. Robin Sharma, The 5 AM Club: Own Your Morning, Elevate Your Life, HarperCollins, 2020.

R4. Carol S. Dweck, Mindset: The New Psychology of Success, Random House, 2016.

R5. Daniel H. Pink,Drive: The Surprising Truth About What Motivates Us, Riverhead Books, 2018.

R6. John C. Maxwell, Leadershift: 11 Essential Changes Every Leader Must Embrace, Harper Collins, 2019.

Online Resources:

1. Coursera – Personal Development Specialization (https://www.coursera.org)
2. edX – Leadership and Emotional Intelligence Courses (https://www.edx.org)
3. FutureLearn – Mindfulness and Resilience Training (https://www.futurelearn.com)
4. MindTools – Practical resources on leadership, communication, and emotional intelligence (https://www.mindtools.com)
5. Positive Psychology – Articles and tools on resilience, gratitude, and well-being (https://positivepsychology.com)
6. TED Talks – Inspirational talks on leadership, communication, and self-growth (https://www.ted.com)
7. Harvard Business Review (HBR) – Leadership, negotiation, and workplace communication (https://hbr.org)

25HS203	M.Tech., II-SEMESTER **YOGA AND MEDITATION** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(AUDIT COURSE-II)**	L	T	P	C
		2	0	0	0

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Explain the eight limbs of Ashtanga Yoga and their significance in achieving physical, mental, and spiritual well-being.

CO2. Explain the principles of Yama and Niyama and their role in ethical and personal discipline in yoga practice.

CO3. Practice the principles of Yama and Niyama as ethical guidelines for disciplined and harmonious living.

CO4. Explain the role of Asana and Pranayama in promoting physical fitness and mental well-being.

CO5. Practice yoga poses and pranayama techniques and their benefits for mind and body.

SYLLABUS:

UNIT-I: ASHTANGA YOGA (05 Periods)

Definitions of Eight parts of yoga - Yama (Restraints / Moral Disciplines), Niyama (Observances / Personal Disciplines), Asana (Postures / Physical Exercises), Pranayama (Breath Control / Life Force Regulation), Pratyahara (Withdrawal of Senses / Sense Control), Dharana (Concentration / Focus), Dhyana (Meditation / Contemplation), Samadhi (Absorption / Liberation)

UNIT-II: YAMA AND NIYAMA IN ASHTANGA YOGA (07 Periods)

Yama (Moral Restraints) - Ahimsa (Non-violence), Satya (Truthfulness), Asteya (Non-stealing), Brahmacharya (Moderation / Celibacy), Aparigraha (Non-possessiveness / Non-greed).

Niyama (Personal Disciplines / Observances) - Shaucha (Cleanliness / Purity), Santosha (Contentment), Tapas (Discipline / Austerity), Swadhyaya (Self-study / Study of Scriptures), Ishwar Pranidhana (Surrender to God / Devotion).

UNIT-III: DO'S AND DON'TS IN LIFE – YAMA AND NIYAMA (06 Periods)

Do‘s and Don‘ts in life.

UNIT-IV: ASANA AND PRANAYAM (06 Periods)

Asana - Body development and steadiness; Pranayam - Breath control and energy regulation

UNIT-V: YOGA POSES AND PRANAYAMA – BENEFITS AND TYPES (06 Periods)

Various yoga poses and their benefits for mind and body

Regularization of breathing techniques and its effects-Types of pranayama

Total Periods: 30

Text Books:

T1. Swami Prabhavananda and Christopher Isherwood (translation & commentary), Patanjali Yoga Sutras,Sri Ramakrishna Math, 1953.

T2. B.K.S. Iyengar, Light on Yoga, Thorsons, 2003.

Reference Books:

R1. T.K.V. Desikachar, The Heart of Yoga: Developing a Personal Practice, Inner Traditions 2nd Edition, 1999.

R2. Acharya Yatendra, Yoga & Stress Management, Fingerprint Publishers, 2019

R3. Yamini Muthanna, The Power of Yoga, Om Books International, 2015.

R4. Nayaswami Devarshi, Kriya Yoga: Spiritual Awakening for the New Age, Ananda Sangha Publications, 2023.

Online Resources:

1. NPTEL / SWAYAM Online Courses – Yoga and Physical Education modules.
2. AYUSH Ministry Website: https://yoga.ayush.gov.in – official yoga resources, protocols, and research.
3. Yoga Journal: https://www.yogajournal.com – practical guides, research updates, asana tutorials.
4. Art of Living Foundation: https://www.artofliving.org – pranayama, meditation, and wellness practices.
5. YouTube Channels (scholarly & practice-based):
    a. Sivananda Yoga Vedanta Centre
    b. Yoga with Adriene (for practical asana guidance)

2512301	M.Tech. III-EMESTER STABILITY ANALYSIS OF SLOPES (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering, Engineering Mechanics, statics

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Identify slope types, major causes and mechanics of slope failure

CO2. Execute hand and software-based stability calculations.

CO3. Construct and interpret flow nets, Predict phreatic surface location.

CO4. Compare and select appropriate stabilization technique for cases.

CO5. Use and interpret modern monitoring devices, Plan effective risk management strategies for slopes.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF SLOPE STABILITY AND FAILURE MECHANISMS

(08 Periods)

Types of slopes and common causes of slope failures including natural and anthropogenic factors, Classification of slope failures: planar, rotational, wedge, and flow failures, Mechanics of slope failure: shear strength of soils and rock, stress distribution, and failure criteria, Modern understanding of failure modes including progressive failure and rapid drawdown effects, Introduction to the role of water and pore pressure in slope failure.

UNIT-II: STABILITY ANALYSIS TECHNIQUES – CLASSICAL AND MODERN APPROACHES (12 periods)

LIMIT EQUIBILIBRIM METHODS (LEM): Infinite and finite slope analyses with dry and submerged conditions, Factor of Safety (FOS) concept and its calculation, Pore pressure coefficients and their significance, Mass analysis and wedge method, Friction circle method of analysis, Detailed methods of slices: Ordinary, Bishop's, Janbu's, Morgenstern-Price, and Spencer's methods.

INTRODUCTION TO NUMERICAL METHODS: Finite Element Method (FEM) and Finite Difference Method (FDM) for slope stability, Probabilistic methods and reliability analysis.

UNIT-III: SEEPAGE AND FLOW THROUGH EARTH STRUCTURES INFLUENCING STABILITY (09 Periods)

Fundamentals of seepage in soil slopes and earth dams, Two-dimensional seepage flow and solutions to Laplace's equation, Graphical methods and flow net construction, Determination and interpretation of phreatic surfaces, Seepage influences under steady and transient conditions including drawdown, Seepage control techniques in earth dams, Impact of seepage on slope stability and seepage-induced failures.

UNIT-IV: SLOPE STABILIZATION AND REINFORCEMENT TECHNIQUES (11 Periods)

Stabilization of slopes by geometric modification – flattening, benching, and load reduction, Drainage techniques: Surface and subsurface drainage systems, Use of synthetic filters and drainage galleries, Mechanical stabilization, Retaining structures: gravity walls, cantilever walls, gabions, Rock bolting, soil nailing, ground anchors, shotcreting, Use of geo synthetics for reinforcement, Chemical stabilization methods, Vegetative stabilization and erosion control, Recent advancements in slope stabilization technology.

UNIT-V: INSTRUMENTATION, MONITORING AND RISK MANAGEMENT OF SLOPE

(08 Periods)

Slope instrumentation techniques including: Inclinometers, extensometers, piezometers, strain gauges, Real-time monitoring tools: automated total stations, radar, micro seismic systems, Data interpretation and early warning systems, Slope movement analysis and threshold determination, Maintenance and management strategies for slopes, Risk assessment, hazard mapping, and slope failure prediction, Case studies of slope failure and lessons learned from monitoring

Total Periods: 48

Text books

T1. Engineering Geology and Rock Mechanics, Duncan C. Wyllie, J.M. Coulthard, J. C. Cripps, M. G. Culshaw, 2nd edition, 2014

T2. Piled Foundations in Weak Rock, J. A. Gannon, G. G. T. Masterton, W. A. Wallace et al. Shunchuan Wu, Liping Li, Xiaoping Zhang, 1st Edition, 1999.

Reference Books:

R1. Slope Stability Analysis and Stabilization: New Methods and Insight, C.K. Lau & Y.M. Cheng, 2nd Edition, 2014.

R2. Slope Stability Analysis and Stabilization: New Methods and Insight, C.K. Lau & Y.M. Cheng, 2nd Edition, 2014.

R3. Slope Stability Analysis and Stabilization, C.K. Lau & Y.M. Cheng, 1st Edition, 2008.

R4. Slope Stability and Stabilization Methods, Abramson, 2nd Edition, 2001.

R5. Slope Stability Analysis and Stabilization, C.K. Lau & Y.M. Cheng, 1st Edition, 2008.

Web Resources:

1. https://archive.nptel.ac.in/courses/105/104/105104098/
2. https://archive.nptel.ac.in/content/storage2/courses/105101087/01-Ltexhtml/p2/p.html

2512302	M.Tech., III-SEMESTER DESIGNING WITH GEOSYNTHETICS (GEOTECHNICAL ENGINEERING)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering, Engineering Geology

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Classify geosynthetics and identify their basic functions, relate polymer type, manufacturing process, and environmental exposure to long-term performance and sustainability of geosynthetics

CO2. Select geotextiles based on required functions and performance criteria for roads, railways, embankments, filters and drains. Use test data (strength, permittivity, AOS, clogging resistance, durability) and design charts to proportion geotextile solutions

CO3. Interpret key geogrid properties (tensile strength, junction strength, creep, interaction coefficients) and carry out preliminary design of geogrid/geocell reinforced walls, slopes and road bases.

CO4. Interpret transmissivity, creep reduction and intrusion effects for geonets and geocomposites and size geosynthetic drainage layers for leachate, gas or sub-surface drainage under given hydraulic and loading conditions.

CO5. Interpret essential geomembrane and GCL properties, propose barrier system cross sections (liners/covers) for waste containment and hydraulic structures at the concept level, including survivability and basic stability considerations.

SYLLABUS:

UNIT-I: OVERVIEW, MATERIALS AND TYPES OF GEOSYNTHETICS (10 periods)

Introduction and evolution of geo synthetics: global and Indian practices; polymeric materials: PP, PET, PE, PVC, HDPE; their properties and degradation (oxidation, UV, chemical). **Types and basic description**: Geotextiles, geogrids, geonets, geomembranes, Geosynthetic clay liners (GCLs), geocomposites, geopipes, Geofoam, geocells; functional classification (separation, reinforcement, filtration, drainage, barrier). Manufacturing methods and quality control basics.

Sustainability aspects: life-cycle thinking, carbon footprint, recyclability of geosynthetics

UNIT-II: Designing with Geotextiles (Functions, Properties, Tests, Applications) (10 Periods)

Geotextile functions and mechanisms: separation, filtration, drainage, reinforcement, protection, erosion control.Design methods for Separation and roadway reinforcement (unsealed/low-volume roads – Giroud–Noiray style concepts). Filtration and drainage: retention and permeability criteria, anti-clogging concepts. Basic soil reinforcement with geotextiles (low walls, slopes – overview).

Properties and test methods: Physical (mass per unit area, thickness), mechanical (tensile, puncture, seam strength), hydraulic (permittivity, AOS) and endurance (UV, oxidation).

Construction methods and techniques: handling, overlaps, protection from damage, QC/QA.

Emerging themes: geotextiles in green infrastructure and climate-resilient drainage.

UNIT-III: Designing with Geogrids and Geocells (Reinforcement) (10 Periods)

Types of geogrids (uniaxial, biaxial, triaxial) and geocells; load transfer mechanisms. Properties and test methods: tensile tests, junction efficiency, creep, pullout and sliding interaction, durability. Design of reinforced soil systems: Geogrid-reinforced walls and slopes (simplified limit equilibrium concepts,

layout of reinforcement). Embankments and approach fills on soft soils – basal reinforcement overview. Pavement subgrade stabilization and base reinforcement – functional design aspects. Construction and QA/QC issues: compaction, connection detailing, facing options, field monitoring.
Current developments: geogrid-reinforced systems in seismic areas and use of geocells in low-carbon embankments

UNIT-IV: Designing with Geonets & Drainage Geocomposites (08 Periods)
Geonets: types, structure, flow channels; key tests (transmissivity under load and gradient, creep).
Geocomposites: geonet–geotextile composites, cuspated cores, prefabricated vertical drains (concept). Design for Leachate collection in landfills Drainage behind retaining walls and under pavements. Gas collection layers in landfill caps.
Design critique: influence of clogging, intrusion, biological growth, and long-term reduction factors; comparison with granular drains. Construction methods: placement, protection, and connection to collection pipes.

UNIT-V: Geomembranes, GCLs and Barrier / Liner Systems (10 Periods)
Geomembrane types (HDPE, LLDPE, PVC, bituminous) and GCLs; barrier geocomposites. Properties & tests: mechanical, hydraulic, endurance (chemical exposure, stress cracking, UV) and survivability requirements. Liquid and solid waste containment systems: Reservoir and canal liners, water conveyance. Landfill liners and covers – composite liners (geomembrane + clay/GCL), leakage and diffusion concepts. Underground storage tanks and heap leach pads – geotechnical aspects. Interface shear strength, slope stability of liners and use of protection layers.
Construction QA/QC: panel layout, seaming, destructive and non-destructive seam testing, CQA documentation.

Emerging practices: leak detection systems, sensor-based monitoring, climate-resilient landfill and lagoon designs.

Total Periods: 48

Text books:
T1. Designing with Geosynthetics, Koerner, R. M., 6th ed., Vol. 1 & 2
T2. Handbook of Geosynthetic Engineering, Shukla, S. K. (Ed.), CRC Press.

Reference Books:
R1. NPTEL course notes: Geosynthetics and Reinforced Soil Structures (IIT Madras).
R2. NPTEL course notes: Geosynthetics Engineering in Theory and Practice.
R3. Selected IGS case histories and conference papers (IGS Library).
R4. IS 18591 – 2024 Code of Practice on Geosynthetic Reinforced Soil Structures.
R5. IRC: SP:59 “Guidelines for Use of Geotextiles in Road Pavements and Associated Works.
R6. IS 17373:2020 “Geosynthetics — Geogrids used in Reinforced Soil Retaining Structures - Specification

Web Resources:
1. NPTEL: Geosynthetics and Reinforced Soil Structures.
2. NPTEL: Geosynthetics Engineering in Theory and Practice.
3. IGS Digital Library – papers, design examples and case histories.
4. Manufacturer design guides (TenCate, NAUE, HUESKER, etc.) for current product-specific data.
5. Supplementary book/info pages for Designing with Geosynthetics 6th ed.

2512303	M.Tech. III-SEMESTER GEOTECHNICAL EARTH QUAKE ENGINEERING (GEOTECHNICAL ENGINEERING) (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Pre-Requisites: Geotechnical Engineering, Structural Dynamics

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain plate tectonics, fault sources, and seismic wave propagation.
CO2. Interpret seismograph records and ground motion parameters.
CO3. Perform 1D ground response analysis using equivalent linear and nonlinear methods.
CO4. Assess liquefaction potential using cyclic stress/strain approaches.
CO5. Apply seismic design principles to foundations and retaining structures.

SYLLABUS:

UNIT-I: EARTHQUAKE SIESOMOLOGY AND SOURCE CHARACTERIZATION (08 Periods)

Causes of earthquakes: tectonic processes, human-induced events, Plate tectonics and fault mechanics, Seismic waves: P, S, surface waves; propagation and effects, elastic rebound theory, Quantification: magnitude scales (Richter, moment), intensity scales (MMI), Earthquake source models: point, finite, stochastic, Recent advances: real-time seismology, global seismic networks, AI in event detection

UNIT-II: EARTHQUAKE GROUND MOTION AND SITE EFFECTS (10 Periods)

Seismographs: principles, types, data interpretation, Ground motion characteristics: amplitude, frequency, duration, response spectra, local site effects: soil amplification, basin effects, topographic effects, Design earthquake: selection, probabilistic vs. deterministic approaches, Design spectra: code-based (IS 1893, EC8), site-specific development, Performance-based design and hazard levels, Recent advances: ground motion databases, machine learning in ground motion prediction.

UNIT-III: GROUND RESPONSE ANALYSIS (08 Periods)

1D ground response analysis: theory and assumptions, Linear and equivalent linear approaches, Nonlinear soil behaviour: strain-dependent modulus and damping, Computer code "SHAKE": input, output, interpretation, Recent advances: 2D/3D site response, probabilistic analysis, integration with GIS, Use of modern geotechnical modelling software.

UNIT-IV: LIQUEFACTION AND LATERAL SPREADING (10 Periods)

Liquefaction phenomena: mechanisms, historical case studies, Susceptibility criteria: historical, geological, compositional, state Evaluation methods: cyclic stress approach, cyclic strain approach Lateral deformation and spreading: mechanisms, prediction models, Criteria for mapping liquefaction hazard zones, Recent advances: data-driven prediction models, neural networks, DEM simulation

UNIT-V: SEISMIC DESIGN OF FOUNDATIONS, SLOPE STABILITY, AND ETAINING WALLS COURSE OBJECTIVES (12 Periods)

Seismic design of shallow and deep foundations: codal provisions (IS 1893, IS 13920, EC8), Seismic slope stability analysis: limit equilibrium, Newmark sliding block, seismic coefficient method, Internal stability and weakening instability: mechanisms, mitigation, Seismic design of retaining walls: cantilever, gravity, reinforced soil walls, Performance-based design, allowable permanent displacement, Recent advances: probabilistic design, use of advanced modelling software

Total Periods: 48

Text books:

T1. Engineering Geology and Rock Mechanics, Duncan C. Wyllie, J. M. Coulthard, J. C. Cripps, M. G. Culshaw, 2nd Edition, 2014

T2. Rock Mechanics, J. A. Gannon, G. G. T. Masterton, W. A. Wallace et al. Suncheon Wu, Liping Li, Xiaoping Zhang, 1st Edition, 2026

Reference Books:

R1. Earthquake Engineering by Haresh S. Shah & C.V. Raman, 1st Edition, 1996

R2. Geotechnical Earthquake Engineering by Steven L. Kramer, 1st Edition, 1996

R3. Geotechnical Earthquake Engineering by Steven L. Kramer, 1st Edition, 2008

R4. Soil Liquefaction During Earthquakes by I.M. Idriss & R.W. Boulanger, 1st Edition, 2008

R5. Foundation Design for Earthquake Engineering by S. Prakash & P. K. Sharma, 1st Edition, 1990

Web Resources:

1.https://archive.nptel.ac.in/courses/105/104/105104098/

2.https://archive.nptel.ac.in/content/storage2/courses/105101087/01-Ltexhtml/p2/p.html

2512351	M.Tech., III-SEMESTER DISSERTATION PHASE–I (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	20	10

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Identify and formulate a research problem in the chosen area of specialization through comprehensive literature review.

CO2. Analyze existing methods and technologies related to the problem and identify research gaps.

CO3. Design a suitable methodology, framework, or experimental setup to address the identified research problem.

CO4. apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. prepare and present a detailed project proposal and preliminary results effectively through technical reports and seminars.

CO6. make decisions to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

2512352	M.Tech., III-SEMESTER INDUSTRY INTERNSHIP (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	0	2

Pre-Requisites: All Courses

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Demonstrate the organizational structure, workflow, and professional practices followed in industry.

CO2. Apply engineering knowledge and technical skills to solve real-world industrial problems.

CO3. Develop professional competencies such as teamwork, communication, time management, and work ethics in an industrial environment.

CO4. Prepare and present a comprehensive report reflecting practical learning, observations, and outcomes.

2512353	M.Tech., III-SEMESTER CO-CURRICULAR ACTIVITIES (GEOTECHNICAL ENGINEERING)	L	T	P	C
		0	0	0	1

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Demonstrate participation and engagement in technical and professional co-curricular activities such as seminars, workshops, competitions, and technical events.

CO2. Develop problem-solving, analytical, and innovation skills through active involvement in technical activities.

CO3. Enhance communication, leadership, teamwork, and organizational skills through collaborative participation in co-curricular programs.

CO4. Apply acquired knowledge and skills to improve overall professional competence and lifelong learning abilities.

2512381	M.Tech., III-SEMESTER GREEN BUILDINGS (Common to AIDS, PS, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Apply principles of green building design to plan and evaluate sustainable buildings by integrating energy efficiency, water conservation, eco-friendly materials, and sustainable construction practices.

CO2. Explain green building concepts, rating systems, and sustainable practices for energy, water, and materials efficiency.

CO3. Apply green building design principles to reduce energy demand and integrate renewable and onsite energy systems efficiently.

CO4. Apply energy-efficient HVAC design principles for sustainable air conditioning and green building performance.

CO5. Apply material conservation strategies and indoor environmental quality principles to promote sustainable and healthy buildings.

SYLLABUS:

UNIT-I: INTRODUCTION TO GREEN BUILDING AND SUSTAINABLE FEATURES

(08 Periods)

Introduction to Green Building – Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing a Green Building, Important Sustainable Features for Green Buildings.

UNIT-II: GREEN BUILDING CONCEPTS AND SUSTAINABLE PRACTICES

(09 Periods)

Green Building Concepts and Practices – Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT-III: GREEN BUILDING DESIGN AND ENERGY OPTIMIZATION

(09 Periods)

Green Building Design – Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-friendly Captive Power Generation for Factories, Building Requirements.

UNIT-IV: AIR CONDITIONING AND ENERGY-EFFICIENT BUILDING SYSTEMS

(09 Periods)

Air Conditioning – Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling Towers, Selection of Air Handling Units, Pre-cooling of Fresh Air, Interior

Lighting Systems, Key Features of the Building, Eco-friendly Captive Power Generation for Factories, Building Requirements.

UNIT-V: MATERIAL CONSERVATION AND INDOOR ENVIRONMENTAL QUALITY (09 Periods)

Material Conservation – Handling of Non-Process Waste, Waste Reduction During Construction, Materials with Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health – Air Conditioning, Indoor Air Quality, Sick Building Syndrome, Tobacco Smoke.

Total Periods: 45

Text Books:

T1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.

T2. Green Building Hand Book , Tomwoolley and Samkimings, 2009.

References:

R1. Complete Guide to Green Buildings, Trish riley

R2. Standard for the design for High Performance Green Buildings, Kent Peterson, 2009

R3. Energy Conservation Building Code –ECBC-2020, BEE.

2512382	M.Tech., III-SEMESTER ROAD SAFETY ENGINEERING (Common to AIDS, PS, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Analyze accident data to identify causes and recommend safety improvements.

CO2. Apply statistical methods to analyze traffic data and improve accident prevention measures.

CO3. Analyze vehicle, human, and geometric design factors to recommend safe road design and traffic control measures.

CO4. Classify traffic signs and road markings and evaluate their design and role in enhancing road safety.

CO5. Evaluate traffic management systems, road safety audit processes, and ITS applications to improve road safety performance.

SYLLABUS:

UNIT-I: ACCIDENT INVESTIGATION AND ROAD SAFETY RISK MANAGEMENT

(08 Periods)

Accident Investigations and Risk Management, Collection of Accident Data, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction, Condition and Collision Diagram.

UNIT-II: TRAFFIC ENGINEERING AND STATISTICAL ANALYSIS IN ROAD SAFETY

(09 Periods)

Traffic Engineering Studies; Statistical Methods In Traffic Safety Analysis – Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons- Traffic Management Measures And Their Influence On Accident Prevention.

UNIT-III: ROAD SAFETY IN TRANSPORT PLANNING AND GEOMETRIC DESIGN

(09 Periods)

Road Safety in ` Transport Planning and Geometric Design: Vehicle and Human Characteristics, Road Design and Safety Elements, Redesigning Junctions, Cross Section Improvements, Traffic Control, Traffic Calming Measures, Road Safety Furniture

UNIT-IV: ROLE OF SIGNS AND MARKINGS IN SAFETY

(08 Periods)

Types of Signs – Design Specifications – Guidelines for Installation – Role of Signs in Safety; Types of Road Markings – Design Specifications – Role of Road Markings in Safety.

UNIT-V: TRAFFIC MANAGEMENT SYSTEMS AND ROAD SAFETY AUDIT

(10 Periods)

Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Road Safety Improvement Strategies, ITS and Safety.

Total Periods: 45

Text Books:

T1. Traffic Engineering and Transportation Planning, L.R. Kadiyali, Khanna Publishers

T2. Fundamentals of Transportation Engineering, C.S.Papacostas, Prentice Hall India.

T3. Road Safety by NCHRP

References:

R1. Transportation Engineering - An Introduction, C.Jotin Khisty, B. Kent Lall

R2. Fundamentals of Traffic Engineering, Richardo G Sigua

R3. Handbook of Road Safety Measures, Second Edition, Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson

		L	T	P	C
2598381	**M.Tech., III-SEMESTER** **ADVANCED DATA STRUCTURES AND ALGORITHMS** (Common to PS, Geo-Tech, RE, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Implement and manipulate linear data structures like singly/doubly linked lists, circular lists, stacks, and queues using dynamic memory allocation.

CO2. Apply and analyze searching and sorting algorithms including linear, binary search, bubble, selection, insertion, quick, and merge sort.

CO3. Design and implement dictionaries and hashing techniques to efficiently store and retrieve data.

CO4. Construct and operate on trees and priority queues, performing insertion, deletion, and traversal operations.

CO5. Compare and implement balanced search trees (AVL, Red-Black, Splay, B-Trees) for optimized data access and storage.

SYLLABUS:

UNIT-I: INTRODUCTION **(09 Periods)**

Introduction to Data Structures, Singly Linked Lists, Doubly Linked Lists, Circular Lists-Algorithms. Stacks and Queues: Algorithm Implementation using Linked Lists.

UNIT-II: SEARCHING AND SORTING **(09 Periods)**

Linear and Binary Search Methods, Sorting: -Basic sorting techniques, Radix Sort, Bucket Sort, Shell Sort Trees- Binary trees, Properties, Representation and Traversals, Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.

UNIT-III: DICTIONARIES AND HASHING **(09 Periods)**

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.

Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing

UNIT-IV: PRIORITY QUEUES **(09 Periods)**

Definition, ADT, Realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion .Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations-Searching, Insertion, Deletion.

UNIT-V: SEARCH TREES **(09 Periods)**

AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching, Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.

Total Periods: 45

Text Books:

T1. Data Structures: A Pseudo Code Approach, Richard F.Gilberg, Behrouz A. Forouzon and Cengage, 2/e.

T2. Data Structures, Algorithms and Applications in java, SartajSahni, University Press, 2/e.

Reference Books:

R1. Data Structures and Algorithm Analysis, Mark Allen Weiss, Pearson, 2/e.

R2. Data Structures and Algorithms, Adam Drozdek, Cengage, 3/e,

R3. C and Data Structures: A Snap Shot Oriented Treatise using Live Engineering Examples, N.B.Venkateswarulu, E.V.Prasad and S Chand & Co.

	M.Tech., III-SEMESTER	L	T	P	C
2598382	**CLOUD COMPUTING** (Common to PS, Geo-Tech, RE, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Explain cloud computing fundamentals including characteristics, deployment and service models, multitenancy, cloud economics, networking role, and platforms such as Amazon EC2, Google App Engine, and Microsoft Azure.

CO2. Demonstrate virtualization concepts including server, storage, network and service virtualization, virtual machines, virtualization management, performance measurement, and hypervisors such as KVM, Xen, and VMware ESXi.

CO3. Explain relational databases, cloud file systems such as Google File System and Hadoop Distributed File System, data models including Bigtable, Apache HBase, Amazon Dynamo, and the MapReduce model with its parallel computing efficiency.

CO4. Explain cloud security fundamentals, including security architecture, vulnerability assessment, privacy, trusted computing, secure execution environments, identity and access management, and autonomic security.

CO5. Analyze issues in cloud computing including real-time application deployment, inter-cloud challenges, QoS and monitoring, dependability, data migration, streaming, and the role of cloud middleware.

SYLLABUS:

UNIT-I: CLOUD COMPUTING FUNDAMENTALS (09 Periods)

Definition, characteristics, components, Cloud service provider, the role of networks in Cloud computing, Cloud deployment models- private, public & hybrid, Cloud service models, multitenancy, Cloud economics and benefits, Cloud computing platforms - IaaS: Amazon EC2, PaaS: Google App Engine, Microsoft Azure, SaaS.

UNIT-II: VIRTUALIZATION TECHNOLOGIES (09 Periods)

Virtualization concepts, Server virtualization, Storage virtualization, Storage services, Network virtualization, Service virtualization, Virtualization management, Virtualization technologies and architectures, virtual machine, Measurement and profiling of virtualized applications. Hypervisors: KVM, Xen, VMware hypervisors and their features.

UNIT-III: DISTRIBUTED DATA MANAGEMENT AND PROCESSING (09 Periods)

Relational databases, Cloud file systems: GFS and HDFS, Bigtable, HBase and Dynamo. MapReduce and extensions: Parallel computing, the map -Reduce model, Parallel efficiency of Map Reduce.

UNIT-IV: CLOUD SECURITY (09 Periods)

Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud. Cloud computing security architecture: General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro - architectures; Identity Management and Access control, Autonomic security.

UNIT-V: ADVANCED CLOUD COMPUTING ISSUES (09 Periods)

Issues in cloud computing Implementing real time application over cloud platform, Issues in Inter - cloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware.

Total Periods: 45

Text Books:

T1. Enterprise Cloud Computing, Gautam Shroff, Cambridge publication.

T2. Enterprise Cloud Computing Technology Architecture Applications, Gautam Shroff, Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.

Reference Books:

R1. Cloud Security, Ronald Krutz and Russell Dean Vines, Wiley -India.

R2. Cloud Computing, Dr. Kumar Saurabh, Wiley Publication.

R3. Cloud Computing Strategies, Dimitris N. Chorafas, CRC Press; 1 edition [ISBN: 1439834539],2010

R4. Cloud Computing, A Practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter, McGraw Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.

R5. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley Publication, 2011.

R6. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly Media Inc, 2009.

2598383	M.Tech., III-SEMESTER AI TOOLS (Common to PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Explain the fundamentals and evolution of AI tools.
CO2. Use AI tools for text, language, and communication tasks.
CO3. Apply AI tools for image, audio, and video generation.
CO4. Utilize AI tools for coding, research, and productivity enhancement.
CO5. Analyze ethical, security, and application-oriented aspects of AI tools.

SYLLABUS:

UNIT-I: INTRODUCTION TO AI TOOLS (09 Periods)

Definition of Artificial Intelligence, Evolution of AI and Intelligent Systems, Categories of AI Tools (Generative, Analytical, Assistive), Rule-based vs Learning-based AI Tools, Overview of Machine Learning & Deep Learning Tools, AI Tool Ecosystem (OpenAI, Google, Meta, Microsoft), Cloud-based AI Tools, Future Trends in AI Tool Development.

UNIT-II: TEXT & LANGUAGE AI TOOLS (09 Periods)

Natural Language Processing (NLP) Basics, ChatGPT – Architecture and Capabilities, Prompt Engineering Concepts, AI Tools for Content Writing, AI Tools for Email, Resume & Report Generation, AI-based Translation and Summarization Tools, AI Chatbots and Virtual Assistants, Limitations and Bias in Language AI Tools.

UNIT-III: IMAGE, AUDIO & VIDEO AI TOOLS (09 Periods)

Image Generation Tools (DALL·E, Midjourney, Stable Diffusion), Image Editing and Enhancement using AI, AI Tools for Graphic Design & Posters, Text-to-Speech AI Tools (ElevenLabs, Google TTS), Speech-to-Text AI Tools, AI-based Video Creation Tools, Avatar and Animation AI Tools, Applications in Media, Education & Healthcare.

UNIT-IV: AI TOOLS FOR CODING, RESEARCH & PRODUCTIVITY (09 Periods)

AI Tools for Programming Assistance, Code Generation and Debugging using AI, AI Tools for Data Analysis, AI Tools for Research Paper Writing, AI Tools for Literature Survey and Citations, AI in Project Management, AI Tools for Presentation Creation, AI Tools for Automation and Workflow Optimization.

UNIT-V: ETHICAL, SECURITY & APPLIED AI TOOLS (09 Periods)

Ethical Issues in AI Tool Usage, Data Privacy and Security Concerns, AI Tool Regulations and Policies, AI Tools in Education, AI Tools in Healthcare, AI Tools in Finance and Business, AI Tools in Smart Cities and Governance, Responsible and Sustainable AI Practices.

Total Periods: 45

Text Books:

T1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Pearson Education, 4th Edition, 2021.
T2. AI for Everyone, Michael Miller, Pearson, 2020.
T3. Artificial Intelligence for Business, Liam Ottley, Wiley, 2022.

Reference Books:

R1. AI Superpowers: China, Silicon Valley, and the New World Order, Kai-Fu Lee, Houghton Mifflin Harcourt, 2018.

R2. Artificial Intelligence in Practice, Bernard Marr, Wiley, 2020.

R3. Ethical Guidelines for Trustworthy AI, European Commission, 2019.

2584381	M.Tech., III-SEMESTER IOT AND ITS APPLICATIONS (Common to AIDS, PS, Geo-Tech, RE) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Apply the Knowledge in IOT Technologies and Data management.

CO2. Determine the values chains Perspective of M2M to IOT.

CO3. Implement the state of the Architecture of an IOT.

CO4. Compare IOT Applications in Industrial & real world.

CO5. Demonstrate knowledge and understand the security and ethical issues of an IOT.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF IOT (09 Periods)

Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards.

UNIT-II: IOT PROTOCOLS (09 Periods)

IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT.

UNIT-III: DESIGN AND DEVELOPMENT (09 Periods)

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi with Python Programming.

UNIT-IV: DATA ANALYTICS AND SUPPORTING SERVICES (09 Periods)

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

UNIT-V: CASE STUDIES/INDUSTRIAL APPLICATIONS (09 Periods)

IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).

Total Periods: 45

Text Books:

T1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.

T2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.

Reference Books:

R1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).

R2. From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence‖, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.

R3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.

	M.Tech., III-SEMESTER	L	T	P	C
2552381	PHOTOVOLTAIC SYSTEMS (Common to AIDS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Understand solar radiation principles, measurement techniques, and solar cell characteristics and performance.

CO2. Explain solar cell manufacturing technologies, PV module design, encapsulation, power rating, hotspot effect, and design qualification standards.

CO3. Explain flat plate arrays, mounting structures, module interconnection, lightning protection, and performance evaluation including temperature coefficients, series resistance, and curve correction factors.

CO4. Explain photovoltaic system types, design considerations, system, battery and inverter sizing, and balance of system components.

CO5. Explain maximum power point tracking techniques, instrument design, and grid-interactive photovoltaic systems.

SYLLABUS:

UNIT-I: SOLAR ENERGY (09 Periods)

Sun and Earth, Solar Spectrum, Solar Geometry, Solar radiation on horizontal and inclined planes, Instruments for measurement of solar radiation, Solar cell, Equivalent circuit, V-I characteristics, Performance improvement.

UNIT-II: SOLAR CELLS (09 Periods)

Manufacture of Solar Cells-Technologies, Design of Solar cells, Photovoltaic modules, Design requirements, Encapsulation systems, Manufacture, Power rating, Hotspot effect, Design qualifications.

UNIT-III: PROTECTION AND MEASUREMENTS (09 Periods)

Flat plate arrays, Support structures, Module interconnection and cabling, Lightning protection, Performance measurement using natural sun light and simulator, Determination of temperature coefficients, Internal series resistance, Curve correction factor.

UNIT-IV: PHOTOVOLTAIC SYSTEMS (09 Periods)

Photovoltaic systems, Types, General design considerations, System sizing, Battery sizing, Inverter sizing, Design examples, Balance of PV systems.

UNIT-V: MAXIMUM POWER POINT TRACKERS (09 Periods)

Maximum power point trackers, Perturb and observe, Incremental conductance method, Hill climbing method, Hybrid and complex methods, Data based and other approximate methods, Instrument design, Other MPP techniques, Grid interactive PV system.

Total Periods: 45

Text Books:

T1. Generating electricity from Sun, F.C.Treble, Pergamon Press.

T2. Photovoltaic systems: Analysis and design, A.K.Mukherjee, Nivedita Thakur, PHI, 2011.

Reference Books:

R1. Solar Photovoltaics: Fundamentals, Technologies and applications, C.S.Solanki, PHI, 2009.

Online Learning Resources:

1. https://nptel.ac.in/courses/117108141

		L	T	P	C
2599381	**M.Tech., III-SEMESTER** **INTEGRATED PRODUCT DESIGN AND DEVELOMENT** (Common to AIDS, PS, Geo-Tech, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Explain design concepts, product development planning and customer requirements

CO2. Generate the concept using creative problem solving methods, concept generation and testing.

CO3. Realize Product Teardown, Specifications, Portfolios and Architecture, configurations and prototyping.

CO4. Demonstrate and classify The Design aspects for Risk, Reliability and Safety and environments.

CO5. Do industrial design, understand intellectual property, robust design and product development economics.

SYLLABUS:

UNIT-I: PRODUCT DEVELOPMENT CONCEPTS (09 Periods)

Design Concepts: Design process – Considerations of a good design – Description of good design process – Design codes and standards. Product Development and Planning Process: Characteristics and challenges of product development – Concept development – Generic product development – Product development process flows –Tyco product development – Product development organizations – Organizational structure and design – Product and process cycles – Technological innovation – Structure of opportunity – Opportunity identification – Product planning process – Types of product development projects. **Identifying Customer Needs**: Process of identifying customer needs – Customer requirements.

UNIT-II: CONCEPT SELECTION, GENERATION AND TESTING (09 Periods)

Concept Generation: Activity – Concept generation process – Creativity and problem solving – Creative thinking methods and design – Functional decomposition and synthesis – Morphological methods – Axiomatic design.

Concept Selection and Testing: Development process – Choosing a concept – Concept screening and scoring – Decision making and evaluation – Methods for testing product concepts.

UNIT-III: EMBODIMENT AND DETAIL DESIGN (09 Periods)

Product Teardown, Specifications, Portfolios and Architecture: Teardown process, methods and applications – Post teardown report – Benchmarking approach and support tools for benchmarking process – Product portfolios architecture – Architecture type – Platform architecture – Target Specifications – Setting the final specifications – Modularity – Implications of the architecture – Establishing the architecture – Delayed differentiation – Platform planning – Related system-level design.

Configuration and Detail Design: Generating, analyzing and evaluating configuration design – Best practices for configuration design – Design for X – Design and manufacturing information – Final design review – Activities beyond detail design.

Prototyping: Principles, types and technologies – Understanding prototypes and planning.

UNIT-IV: DESIGN FOR ENVIRONMENT, MANUFACTURING AND SAFETY

(09 Periods)

Design for Manufacture and Environment: Cross-functional team – Overview of DFM process – Life cycles – Environmental impacts – Design for environment process.

Design for Risk, Reliability and Safety: Classification of societal hazards – Standards – Risk assessment – Design for reliability – Causes of unreliability – Minimizing failure – FMEA – Fault tree analysis – Defects and failure modes – Potential dangers – Guidelines for design for safety – Warning labels.

UNIT-V: INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ECONOMICS

(09 Periods)

Industrial Design: Need – Impact – Industrial design process – Management of the industrial design process –Assessing the quality of industrial design. **Robust Design:** Robust design process.

Intellectual Property: Disclosure – Process of pursuing a patent.

Product Development Economics: Elements of economic analysis and process.

Managing Projects: Understanding and representing tasks – Baseline project planning – Accelerating projects – Project execution – Postmortem project evaluation - Project Portfolio Management (PPM) - Earned Value Management (EVM) - Sustainability and ESG in Project Management.

Total Periods: 45

Text Books:

T1. Product Design and Development, Karl T Ulrich, Steven D Eppinger and Maria C. Yang, 7/e, 2020, McGraw-Hill Education Pvt.Ltd., Noida.

T2. Engineering Design, George E.Dieter and Linda C.Schmidt, 4/e, 2013, McGraw-Hill Education Pvt., Ltd., Noida.

Reference Books:

R1. Product Design, Kevin Otto and Kristin Wood, 1/e, 2003, Pearson Education, India.

R2. Product Development, Anil Mital, Anoop Desai, Anand Subramanian and Aashi Mital, 1/e, 2007, Butterworth-Heinemann, Elsevier.

R3. Integrated Product and Process Design and Development: the Product Realization Process (Special Indian Edition), Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, 2/e, 2010, CRC Press, Taylor & Francis Group, LLC.

R4. Product Design for Engineers, Devdas Shetty, 1/e, 2016, Cengage Learning, India.

R5. Introduction to Product Design and Development for Engineers, Ali Jamnia, 2018, CRC Press, Taylor & Francis Group, LLC.

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc25_me121/preview
2. https://onlinecourses.swayam2.ac.in/imb25_mg123/preview

		L	T	P	C
25HS381	**M.Tech., III-SEMESTER** **ADVANCED NUMERICAL METHODS AND COMPUTATIONAL MATHEMATICS** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

- **CO1.** Analyze conditioning, stability, and error behavior of numerical linear algebra routines for dense and sparse problems.
- **CO2.** Derive and apply finite difference for BVP for linear and nonlinear models.
- **CO3.** Derive and apply finite difference for PDE models; assess consistency and stability with Lax equivalence and CFL ideas.
- **CO4.** Optimize engineering models via unconstrained/constrained methods; justify algorithm selection and tuning using theory and diagnostics.
- **CO5.** Integrate GPU/MPI paradigms and the SciPy stack to build scalable, reproducible computational workflows; profile and validate results.

SYLLABUS:

UNIT-I: NUMERICAL LINEAR ALGEBRA (09 Periods)

Floating- point arithmetic, conditioning, stability, backward/forward error; Direct solvers: LU/Cholesky/QR; pivoting and orthogonality; SVD, low- rank approximations, pseudoinverses; Iterative solvers: Jacobi/Gauss–Seidel/CG/GMRES; basic preconditioning; Sparse matrix formats and operations for large- scale systems; Krylov subspace and Arnoldi/Lanczos overviews.

UNIT-II: DISCRETIZATION OF LINEAR AND NONLINEAR ODEs (09 Periods)

Numerical solutions of initial value problems: (single step and multi -step methods); Stability of the numerical methods for initial value problems; Boundary value problems; shooting method; Finite difference for BVP (second and higher order methods), for linear and nonlinear problems Consistency–stability–convergence.

UNIT-III: DISCRETIZATION OF LINEAR AND NONLINEAR PDEs (09 Periods)

Finite difference methods for parabolic problems explicit and implicit methods, Finite difference for hyperbolic explicit and implicit methods; Elliptic PDE; Consistency, Stability and convergence; Lax equivalence and CFL (Courant–Friedrichs–Lewy) ideas; Iterative solvers and multigrid overview for discretized systems.

UNIT-IV: NUMERICAL OPTIMIZATION AND INVERSE PROBLEMS (09 Periods)

Unconstrained methods: gradient, Newton, quasi- Newton, trust- region; Constrained methods: KKT conditions, interior- point, SQP principles; Nonlinear least squares: Gauss–Newton and Levenberg–Marquardt; Regularization (Tikhonov/L1) and model selection concepts; Scientific Python stack:scipy.optimize.minimize, scipy.optimize.linprog, and scipy.optimize.curve_fit; solver choice and diagnostics.

UNIT-V: HIGH- PERFORMANCE SCIENTIFIC COMPUTING (09 Periods)

Parallel paradigms: data/task parallelism; domain decomposition fundamentals; GPU programming model: threads/warps/memory hierarchy; CUDA libraries; MPI and PETSc for scalable sparse linear

algebra and time- steppers; Performance engineering: profiling, locality, and roofline- style thinking; Python at scale: NumPy/SciPy sparse and vectorization; brief Numba/CuPy ecosystem; end-to-end case sketches in CFD/structures/machine learning numerics.

Total Periods: 45

Text Books:

T1. Numerical Linear Algebra, Trefethen, L. N., and D. Bau III, Twenty- Fifth Anniversary Edition, SIAM, 2023.

T2. Finite Difference Methods for Ordinary and Partial Differential Equations: Steady- State and Time-Dependent Problems, LeVeque, R. J., SIAM, 2007.

T3. Numerical Optimization, Nocedal, J., and S. J. Wright, 2nd ed., Springer, 2006.

Reference Books:

R1. Programming Massively Parallel Processors: A Hands- on Approach, Hwu, W.- M. W., and D. B. Kirk, 4th ed., Elsevier, 2022.

R2. Numerical linera algebra and Application, B. N. dutta, Springer Publications.

R3. SciPy Project, Optimization (scipy.optimize), SciPy Manual and Optimization and Root Finding, SciPy 1.16.2 (stable) Reference.

R4. PETSc/TAO Users Manual, Balay, S., et al. Argonne National Laboratory, ANL-21/39 Rev 3.18release documentation.

R5. Automated Solution of Differential Equations by the Finite Element Method: The FEniCS Book. Logg, A., K.- A. Mardal, and G. N. Wells (eds.). Berlin: Springer, 2012.

R6. Numerical analysis Mathematics of scientific computing, David Kincaid Ward Chenery, AMS Book publishers.

R7. Computational Methods for Partial Differential Equations, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age publications.

		L	T	P	C
25HS382	**M.Tech., III-SEMESTER** **MATHEMATICS FOR MACHINE LEARNING AND DATA SCIENCE** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Analyze linear models and matrix factorizations for dimensionality reduction and feature representation.

CO2. Formulate and solve convex and constrained optimization problems; compare first- and second-order methods.

CO3. Apply probabilistic modeling, Bayesian inference, and information- theoretic measures to estimation and generalization.

CO4. Prove convergence properties or error bounds for selected learning algorithms such as SGD and regularized estimators.

CO5. Evaluate and integrate methods into applications such as PCA, SVMs, and neural networks with appropriate regularization.

SYLLABUS:

UNIT-I: LINEAR ALGEBRA FOUNDATIONS (09 Periods)

Vector spaces, norms, inner products, orthogonality, and projections; Eigenvalues/eigenvectors, spectral theorem, and invariant subspaces; Singular value decomposition, low- rank approximations, and Eckart–Young; Matrix calculus for ML; gradients/Jacobians/Hessians in matrix form; Numerical linear algebra: conditioning, stability, power/QR methods; Feature whitening and centering; PCA link to covariance eigen structure.

UNIT-II: OPTIMIZATION FOR LEARNING (08 Periods)

Unconstrained methods: gradient descent, line search, Newton/quasi- Newton; Constrained optimization: Lagrange multipliers, projected and barrier methods; Convex sets/functions, KKT conditions for nonlinear programing problems; Regularization: l_1/l_2penalties, bias–variance trade-offs in risk minimization; Convergence rates and step- size strategies in deterministic models.

UNIT-III: PROBABILITY AND STATISTICAL LEARNING (10 Periods)

Random variables, expectations, covariance; exponential family basics; Bayesian inference: conjugacy, MAP vs. MLE, posterior predictive analysis; Hypothesis testing and confidence intervals for model comparison; Information measures: entropy, KL divergence, mutual information in learning; Generalization, overfitting, and model selection criteria (e.g., AIC/BIC/VC-style capacity); Concentration and uncertainty quantification for predictions.

UNIT-IV: MODELS AND ALGORITHMS (09 Periods)

Linear and kernel methods: least squares, logistic regression, and SVMs; Dimensionality reduction: PCA, kernel PCA, and manifold intuition; Probabilistic models: Naive Bayes, Gaussian mixtures, EM overview; Neural network mathematics: backpropagation, initialization, normalization; Regularization schemes: weight decay, early stopping, dropout perspectives.

UNIT-V: INTEGRATIVE APPLICATIONS AND WORKED EXAMPLES (09 Periods)

End-to-end ML pipelines: preprocessing, scaling/whitening, and feature engineering; PCA- based exploration and anomaly detection in high- dimensional data; SVMs and convex models for fault diagnosis and predictive maintenance; Bayesian A/B testing and decision- making under uncertainty; Neural network design trade-offs: capacity, optimization, and generalization; Model evaluation: calibration, ROC/PR analysis, and uncertainty reporting.

Total Periods: 45

Text Books:

T1. Mathematics for Machine Learning. Deisenroth, M. P., Faisal, A. A., & Ong, C. S. Cambridge University Press, 2020

T2. Probabilistic Machine Learning: An Introduction, Murphy, K. P., MIT Press, 2022.

T3. Convex Optimization, Boyd, S., & Vandenberghe, L., Cambridge University Press, 2004.

Reference Books:

R1. Deep Learning, Goodfellow, I., Bengio, Y., & Courville, A., MIT Press, 2016

R2. Understanding Machine Learning: From Theory to Algorithms. Shalev- Shwartz, S., & Ben-David, S., Cambridge University Press, 2014

R3. Principal component analysis: a review and recent developments. Jolliffe, I. T., & Cadima, J., Phil. Trans. R. Soc. A, 2016

R4. Elements of Information Theory, Cover, T. M., & Thomas, J. A. 2nd ed. Wiley, 2006.

R5. Probabilistic Machine Learning: Advanced Topic, Murphy, K. P. MIT Press, 2023.

		L	T	P	C
25HS383	**M.Tech., III-SEMESTER** **STATISTICAL LEARNING THEORY AND MATHEMATICAL FOUNDATIONS OF AI** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(OPEN ELECTIVE)**	**3**	**0**	**0**	**3**

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

- **CO1.** Analyze probabilistic models, convergence theorems, and stochastic processes underlying learning algorithms.
- **CO2.** Formulate and prove generalization bounds using VC dimension, Rademacher complexity, and stability.
- **CO3.** Derive and optimize loss/regularization for linear, kernel, and deep models; justify selections by convexity and smoothness properties.
- **CO4.** Evaluate algorithms via bias–variance, PAC guarantees, and information- theoretic criteria such as KL and mutual information.
- **CO5.** Integrate theory to design robust AI solutions for multi- domain engineering applications and communicate findings effectively.

SYLLABUS:

UNIT-I: PROBABILITY AND MEASURE FOUNDATIONS (09 Periods)

Probability spaces, σ- algebras, random variables; expectation and conditional expectation; Inequalities and concentration: Markov, Chebyshev, Hoeffding; LLN and CLT; Modes of convergence and Borel–Cantelli; almost sure vs in- probability convergence; Random processes and martingale basics; optional stopping; Doob's inequality (overview); Markov chains: ergodicity, mixing, stationary distributions for modeling sequences.

UNIT-II: STATISTICAL LEARNING THEORY (09 Periods)

PAC learning model, realizable/agnostic cases; sample complexity and no- free- lunch; VC dimension, shattering, Sauer's lemma; uniform convergence guarantees; Empirical risk minimization and structural risk minimization; capacity control; Rademacher/Gaussian complexities and symmetrization for data- dependent bounds; Algorithmic stability and generalization; regularization and early stopping as capacity control; PAC- Bayes bounds and posterior- based generalization certificates.

UNIT-III: OPTIMIZATION FOR LEARNING (09 Periods)

Convex analysis: Lipschitzness, smoothness, strong convexity; implications for rates; Gradient, stochastic, and variance- reducedethods; step- size and convergence trade-offs; Proximal methods and projected gradients; sparsity via ℓ_1 (Lasso) and shrinkage via ℓ_2 (ridge); Duality and KKT conditions; constrained learning formulations; Nonconvex landscapes in deep networks—saddle points, over-parameterization, and implicit regularization; Generalization–optimization interplay: implicit bias of optimizers.

UNIT-IV: KERNEL AND PROBABILISTIC MODELS (09 Periods)

Reproducing kernel Hilbert spaces, kernel trick, representer theorem; Large- margin methods: SVMs, soft margins, hinge loss; primal–dual views; Gaussian processes: kernels as priors; posterior prediction and uncertainty quantification; Graphical models—Bayesian networks and

Markov/conditional random fields for structured prediction; exact inference (variable elimination, junction tree) and approximate methods (loopy belief propagation, variational); Hidden Markov models; EM for latent- variable learning; Variational inference and message passing for scalable probabilistic AI.

UNIT-V: DEEP LEARNING AND INFORMATION THEORY (09 Periods)

Backpropagation (chain rule), initialization, normalization, and activation design; Loss functions and calibration; cross- entropy, margin losses, and robust objectives; Generalization in deep nets: margins, flat minima, compression, and stability views; Information- theoretic tools: entropy, mutual information, KL divergence; Information bottleneck and representation learning, with links to PAC- Bayes; Worked examples: applying theory to vision, language, and control tasks in engineering.

Total Periods: 45

Text Books:

T1. Understanding Machine Learning: From Theory to Algorithms, Shalev- Shwartz, S., Ben-David, S., Cambridge University Press, first edition, 2014.

T2. Deep Learning, Goodfellow, I., Bengio, Y., Courville, A., MIT Press, 2016.

T3. Pattern Recognition and Machine Learning, Bishop, C. M., Springer, 2006.

Reference Books:

R1. The Nature of Statistical Learning Theory, Vapnik, V. N., Springer, 1995/1998.

R2. Elements of Information Theory, Cover, T. M., Thomas, J. A., 2nd ed., Wiley, 2006.

R3. Foundations of Machine Learning, Mohri, M., Rostamizadeh, A., Talwalkar, A., 2nd ed., MIT Press, 2018.

R4. Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, Schölkopf, B., Smola, A. J., MIT Press, 2002.

R5. Gaussian Processes for Machine Learning, Rasmussen, C. E., Williams, C. K. I., MIT Press, 2006.

25HS384	M.Tech., III-SEMESTER CHEMISTRY OF NANOMATERIALS AND APPLICATIONS IN ENGINEERING (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the basic concepts, scope, natural occurrence, classification, and importance of nanoscience and nanomaterials**.**

CO2. Explain the top-down and bottom-up synthetic methods used for the preparation of nanomaterials**.**

CO3. Understand the principles and applications of various characterization techniques used for analyzing nanomaterials**.**

CO4. Explain the synthesis, properties, and applications of important nanomaterials**.**

CO5. Understand the applications of nanomaterials such as nanoparticles, nanorods, and nanowires in various engineering and technological fields**.**

SYLLABUS:

UNIT-I: BASICS OF NANOMATERIALS (08 Periods)

Introduction**,** Scope of nanoscience and nanotechnology, nanoscience in nature, classification of nanostructured materials, importance of nanomaterials.

UNIT-II: SYNTHESIS OF NANOMATERIALS (10 Periods)

Top-Down approach**,** Inert gas condensation, arc discharge method, aerosol synthesis, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, and chemical vapor deposition method, electrode position method, high-energy ball milling method.

Synthetic Methods**:** Bottom-Up approach**,** Sol-gel synthesis, microemulsions or reverse micelles, co- precipitation method, solvothermal synthesis, hydrothermal synthesis, microwave heating synthesis and sonochemical synthesis.

UNIT-III: TECHNIQUES FOR CHARACTERIZATION (09 Periods)

Diffraction techniques, spectroscopy techniques, electron microscopy techniques for the characterization of nanomaterials, BET method for surface area analysis, dynamic light scattering for particle size determination.

UNIT-IV: STUDIES OF NANO-STRUCTURED MATERIALS (09 Periods)

Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, 2D-nanomaterial (Graphene), core-shell, magnetic nanoparticles, thermoelectric materials, non-linear optical materials.

UNIT-V: ADVANCED ENGINEERING APPLICATIONS OF NANOMATERIALS (09 Periods)

Applications of nanoparticles, nanorods, nano wires in Water treatment, sensors, electronic devices, medical domain, civil engineering, chemical engineering, metallurgy and mechanical engineering, food science, agriculture, pollutants degradation.

Total Periods: 45

Text Books:

T1. NANO: The Essentials, T Pradeep, MaGraw-Hill, 2007.

T2. Textbook of Nanoscience and nanotechnology, B S Murty, P Shankar, Baldev Rai,BB Rath and James Murday, Univ. Press, 2012.

Reference Books:

R1. Concepts of Nano chemistry; LudovicoCademrtiri and Geoffrey A. Ozin & Geoffrey A. Ozin, Wiley-VCH, 2011.

R2. Nanostructures & Nanomaterials; Synthesis, Properties & Applications, Guozhong Cao, Imperial College Press, 2007.

R3. Nanomaterials Chemistry, C. N. R. Rao, Achim Muller, K.Cheetham, Wiley-VCH, 2007.

25HS385	M.Tech., III-SEMESTER PHOTONICS FOR ENGINEERS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Describe how light behaves and propagates in optical media.

CO2. Explain light–matter interaction mechanisms and analyze the working, characteristics, and applications of LEDs, laser diodes, quantum well lasers and various photodetectors.

CO3. Explain key nonlinear effects and analyze the operation of optical modulators and switches such as the Mach–Zehnder Interferometer.

CO4. Analyse fiber parameters and explain the functioning of transmitters, receivers, WDM systems, couplers and resonator-based communication devices.

CO5. Describe the working of photonic sensors and emerging quantum and ultrafast photonic technologies used in sensing, computation and communication.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF PHOTONICS (09 Periods)

Nature of light: wave-particle duality, polarization, coherence. Maxwell's equations and wave propagation in dielectric media. Reflection, refraction, (vector notation) interference, diffraction, dispersion and birefringence.

UNIT-II: PHOTONIC DEVICES AND COMPONENTS – I (09 Periods)

Absorption, spontaneous and stimulated emission. Einstein coefficients, population inversion, optical gain. Semiconductor light sources: LEDs, laser diodes, quantum well lasers. Photodetectors: PIN, avalanche photodiodes, photomultiplier tubes.

UNIT-III: PHOTONIC DEVICES AND COMPONENTS – II (09 Periods)

Nonlinear optical effects – second-harmonic generation, Kerr effect, four-wave mixing. Electro-optic Magneto optic and acousto-optic modulation principles. Optical modulators and switches (Mach Zehnder Interferometer).

UNIT-IV: OPTICAL WAVEGUIDES AND APPLICATIONS (09 Periods)

Optical fibers – numerical aperture, V-number, modes, attenuation, dispersion. Fiber-optic communication systems: transmitters, receivers, multiplexing (WDM), optical couplers, ring resonators.

UNIT-V: PHOTONIC SYSTEMS AND APPLICATIONS (09 Periods)

Photonic sensors – interferometric, fiber Bragg gratings, biosensing. Optical signal processing and computing.

Introduction to quantum photonics: single-photon sources, entanglement, and photonic qubits. Plasmonics and metamaterials, Ultrafast and terahertz photonics.

Total Periods: 45

Text Books:

T1. Fundamentals of Photonics, B.E.A. Saleh & M.C. Teich., Wiley.

T2. Semiconductor Optoelectronics: Physics and Technology, J. Singh, McGraw Hill Edition.

T3. Photonics: Optical Electronics in Modern Communications, A. Yariv & P. Yeh, Oxford Series.

T4. Optical Fiber Communications, G. Keiser, McGraw Hill Edition.

Reference Books:

R1. Optoelectronics: An Introduction, J. Wilson & J.F.B. Hawkes.
R2. Nonlinear Optics, R.W. Boyd.
R3. Electromagnetic waves and radiating systems E. Jordan.

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Pre-Requisites: All Courses

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Implement the proposed methodology or design to develop a functional solution or prototype for the identified research problem.

CO2. Analyze and evaluate the results using appropriate tools, techniques, or experimental methods.

CO3. Interpret results and draw meaningful conclusions with respect to the objectives of the research work.

CO4. Prepare a comprehensive project report and effectively present the research findings through seminars and viva voce.

CO5. make decisions to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

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