# ACADEMIC REGULATIONS
# COURSE STRUCTURE
# AND
# DETAILED SYLLABUS

## M. Tech.
## GEOTECHNICAL ENGINEERING

***(Applicable for the batches admitted from 2015-16)***


**VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**

An Autonomous Institute, Accredited by NAAC with 'A' Grade
NBA Accreditation for CE, EEE, ME, ECE, CSE, EIE, IT B.Tech. Programmes
Approved by AICTE, New Delhi, Affiliated to JNTUH
Recognized as "College with Potential for Excellence" by UGC
Vignana Jyothi Nagar, Pragathi Nagar, Nizampet (S.O), Hyderabad – 500 090, TS, India.
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**VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**

**HYDERABAD**

***An Autonomous Institute***

**Academic Regulations - M.Tech. Programme**
**(Applicable for the batches admitted from the academic year 2015-2016)**

## 1. Introduction

Academic programmes of the institute are governed by rules and regulations as approved by the Academic Council of the institute.

These academic rules and regulations are effective from the academic year 2015-16, for the students admitted into two year post graduate programme offered by the college leading to Master of Technology (M. Tech.) degree in different specializations offered by the departments of Civil Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer Science and Engineering, Information Technology and Electronics and Instrumentation Engineering.

The M.Tech. degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on students who are admitted to the programme after fulfilling all the requirements for the award of the degree.

### 1.1 Eligibility for Admissions

Admission to the above program shall be made subject to the eligibility and qualifications prescribed from time to time. Admissions shall be made on the basis of GATE Rank and merit rank obtained at an Entrance Test conducted by the TSSCHE or as decided by TSSCHE subject to reservations prescribed by the university/ State Government from time to time.

## 2. Programmes of study

The following two year M.Tech. degree programmes of study are offered by the departments at VNR VJIET.

| Department | Specializations |
|---|---|
| ME | 1. Advanced Manufacturing Systems<br>2. Automation<br>3. CAD/CAM |
| CE | 1. Highway Engineering<br>2. Structural Engineering<br>3 Geotechnical Engineering |
| EEE | 1. Power Electronics<br>2. Power Systems |
| CSE | 1. Software Engineering<br>2. Computer Science and Engineering |
| ECE | 1. VLSI System Design<br>2. Embedded Systems |
| EIE | Electronics and Instrumentation |
| IT | Computer Networks and Information Security |

- **'ENGLISH'** language is used as the medium of instruction in all the above programmes.

**3. Attendance requirements**

Each academic year shall be divided into two semesters, each of 90 Instructions days, excluding examination, evaluation, declaration of results etc.

**3.1** A student shall be eligible to appear for the semester end examinations in subject if he / she acquire a **minimum of 75% of attendance in that subject.**

**3.2 Shortage of attendance up to 10% in any subject (i.e., attendance of 65% and above and below 75%) in a semester may be condoned by the Institute Academic Committee based on the rules prescribed by the Academic Council of the Institute from time to time.**

**3.3** A student shall get **minimum required attendance in at least three (03) theory subjects** in the present semester to get promoted to the next semester. In order to qualify for the award of the M.Tech. degree, the student shall complete all the academic requirements of the subjects, as per the course structure.

**3.4** Shortage of **attendance below 65% shall in NO case be condoned**.

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

**3.6** In case the student secures less than the required attendance in any subject(s), he shall not be permitted to appear for the semester end examination in that subject(s). He shall re-register for the subject when offered next.

**4. Evaluation**

**i.** The performance of a student in each semester shall be evaluated subject–wise with a maximum of **100 marks for theory** and **100 marks for practical subjects**. In addition, **mini-project** and **comprehensive viva-voce** shall be evaluated for **100 marks** respectively.

**ii.** For theory subjects, the distribution shall be **40 marks for mid-term evaluation** and **60 marks for the semester end examination**.

❖ **Mid-Term Evaluation (40 M):**

Mid-term evaluation consists of **mid-term examination (30 M)** and **assignment/objective test/ case study/course project (10 M).**

➢ **Mid-term examination (30 M):**

- For theory subjects, two mid-term examinations shall be conducted in each semester as per the academic calendar. Each mid-term examination shall be evaluated for 30 marks.
- Pattern of Mid-term examination:
  3 X 10M = 30 M (three internal choice questions one from each UNIT shall be given, the student has to answer ONE question from each UNIT)
- There shall be TWO mid-term examinations for each subject and the average of two mid-term examinations shall be considered for calculating final mid-term examination marks in that subject.

➢ **Assignment/objective exam/ case study/course project (10 M):**

- Two assignment/objective exam/ case study/course project shall be given to the students covering the syllabus of first mid-term and second mid-term examinations respectively and evaluated for 10 marks each.

- The first assignment/objective exam/ case study/course project shall be submitted before first mid-term examination and the second one shall be submitted before second mid-term examination.
- The average of 2 assignments shall be taken as final assignment marks.

**iii.** For practical subjects, there shall be a **continuous evaluation during the semester for 40 marks and 60 marks for semester end examination**. Out of the 40 marks, **day-to-day work in the laboratory shall be evaluated for 10 marks**, and **15 marks for practical examination** and **15 marks for laboratory record.**

❖ **Semester End Examination (60 M):**

**(a) Theory Courses**

Question paper pattern for semester end examination (60 Marks)

- Paper shall consist of 05 questions of 10 marks each. (05X12M = 60 M)
- There shall be 01 question from each unit with internal choice.

**(b) Practical Courses**

Each laboratory course shall be evaluated for 60 marks. The semester end examination shall be conducted by two examiners, one Internal and other external concerned with the subject of the same / other department / Industry. The evaluation shall be as per the standard format.

**4.1.** **Evaluation of Mini-Project:** There shall be two presentations during the first year, one in each semester. For mini-project 1 and mini-project 2, a student under the supervision of a faculty member, shall collect the literature on a topic, critically review the literature, carry out the mini-project, submit it to the department in a report form and shall make an oral presentation before the departmental Project Review Committee (PRC). The Departmental PRC consists of Head of the Department, supervisor and one senior faculty member of the department. For each mini-project there shall be only internal evaluation of 100 marks. A student has to secure a minimum of 50% to be declared successful.

**4.2.** There shall be a comprehensive viva-voce in II year I semester. The comprehensive viva- Voce shall be conducted by a committee consisting of Head of the Department and two senior faculty members of the department. The comprehensive viva-voce is aimed to assess the students' understanding in various subjects studied during the M.Tech. programme of study. The comprehensive viva-voce shall be evaluated for 100 marks by the committee. There are no internal marks for the comprehensive viva-voce. A student must secure a minimum of 50% to be declared successful.

**4.3.** A student shall be deemed to have secured the minimum academic requirement in a subject 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 mid-term evaluation taken together.

**4.4.** A student shall be given one chance to re-register, after completion of the course work, for each subject, provided the internal marks secured by a student are less than 50% and he has failed in the semester end examination. In such a case student may re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end examination in the re-registered subject(s). Re-registration for the subjects is allowed only if those particular re-registration subjects are the hindrance for the award of Degree. Re-registration is allowed in this case provided the student doesn't have any subject(s) yet to pass other than the re-registration subjects where the internal marks are less than 50% with prior permission.

**4.5.** Laboratory examination for M.Tech. courses must be conducted with two examiners, one of them being laboratory class teacher and second examiner shall be a teacher of same specialization either external or a teacher from the same department other than the teacher who conducted laboratory classes for that batch.

**5. Evaluation of Project / Dissertation Work.**

**5.1 Registration of Project Work:** A student shall be permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

**5.2** A Project Review Committee (PRC) shall be constituted with at least four members namely HOD, PG coordinator of the M.Tech. programme, project supervisor and one senior faculty member of same specialization.

**5.3** After getting permission as per 5.1, a student has to submit, in consultation with the project supervisor, the title, objective and plan of action of his project work to the Departmental PRC for its approval. Only after obtaining the approval of PRC, the student can initiate the project work.

**5.4** If a student wishes to change his supervisor or topic of the project he can do so with the approval of PRC. However, the committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, the date of registration for the project work shall be the date of change of supervisor or topic as the case may be.

**5.5** Internal evaluation of the project shall be on the basis of the seminars (Project reviews) conducted during the second year by the PRC. A student shall submit draft report in a spiral bound copy form.

**5.6** The work on the project shall be initiated in the beginning of the second year and the duration of project is for two semesters. A student is permitted to submit Project work only after successful completion of theory and practical course with the approval of PRC not earlier than 240 days from the date of registration of the project work. For the approval of PRC the student shall submit the draft copy of thesis to the Head of the Department (Through project supervisor and PG coordinator) and shall make an oral presentation before the PRC.

The student is eligible to submit project work if he has published at least one paper covering 70% of the project work and presented his project work in Show and Tell activity.

**5.7** After approval of PRC, every student has to submit three copies of the project dissertation certified by the supervisor to the Department.

**5.8** The dissertation shall be adjudicated by one examiner selected by the Chief Superintendent. For this, HOD shall submit a panel of 3/ 5 examiners, who are eminent in that field with the help of the concerned guide.

**5.9** If the report of the examiner is not favourable, the student shall revise and resubmit the Dissertation, within the time frame as prescribed by PRC. If the report of the examiner is unfavourable again, the dissertation shall be summarily rejected.

**5.10** If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the project supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly report students work as:

A. **Excellent**
B. **Good**
C. **Satisfactory**
D. **Unsatisfactory**

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. The student has to secure any one of the grades as Excellent, Good or Satisfactory on his dissertation and viva-voce. If the report of the viva-voce is unsatisfactory, the student shall retake the viva-voce examination after three months, making modifications as suggested. If he fails to get a satisfactory report at the second viva-voce examination, he has to re-register for the project work as mentioned in clause 5.1. However, the student may select a new guide or new topic or both with the approval of the PRC and submit the project dissertation with a minimum of 240 days from the date of re-registration. Of course, this shall not prejudice the clause 6.1 below.

**6. Award of Degree and Class**

A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and complete it successfully for **not less than two academic years** and **not more than four academic years**.

**6.1** A student, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of his admission, for any reason whatsoever, shall forfeit his seat in M.Tech. Course.

**6.2** A student shall register and put up **minimum academic requirement in all 84 credits** and earn **84 credits.** Marks obtained in all 86 credits shall be considered for the calculation of Cumulative Grade Point Average (CGPA).

**6.3 CGPA System:**

Method of awarding absolute grades and grade points in two year M.Tech. degree programme is as follows:

- Absolute Grading Method is followed, based on the total marks obtained in mid-term evaluation and semester end examinations.
- Grades and Grade points are assigned as given below.

| Marks Obtained | Grade | Description of Grade | Grade Points(GP) Value Per Credit |
|---|---|---|---|
| >=90 | O | Outstanding | 10.00 |
| >=80 and <89.99 | A | Excellent | 9.00 |
| >=70 and <79.99 | B | Very Good | 8.00 |
| >=60 and <69.99 | C | Good | 7.00 |
| >=50 and <59.99 | D | Pass | 6.00 |
| <50 | F | Fail | |
| Not Appeared the Exam(s) | N | Absent | |

The student is eligible for the award of the M.Tech. degree with the class as mentioned in the following table.

| CGPA | Class |
|---|---|
| >= 8.0 | First Class with Distinction |
| >= 7.0 and <8.0 | First Class |
| >= 6.0 and < 7.0 | Second Class |

- **Calculation of Semester Grade Points Average (SGPA):**

- The performance of each student at the end of the each semester shall be indicated in terms of SGPA. The SGPA shall be calculated as below:

$$\mathbf{SGPA} = \frac{\textbf{Total earned weighted grade points in a semester}}{\textbf{Total credits in a semester}}$$

$$\mathbf{SGPA} = \frac{\sum_{i=1}^{p} C_i * G_i}{\sum_{i=1}^{p} C_i}$$

Where Ci = Number of credits allotted to a particular subject 'i'

Gi = Grade point corresponding to the letter grade awarded to the subject 'i'

i = 1,2,…..p represent the number of subjects in a particular semester

**Note: SGPA is calculated and awarded for the students who pass all the courses in a semester.**

- **Calculation of Cumulative Grade Point Average (CGPA):**

The CGPA of a student for the entire programme shall be calculated as given below:

- Assessment of the overall performance of a student shall be obtained by calculating Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all subjects during the course of study.

$$\mathbf{CGPA} = \frac{\textbf{Total earned weighted grade points for the entire programme}}{\textbf{Total credits for the entire programme}}$$

$$\mathbf{CGPA} = \frac{\sum_{j=1}^{m} C_j * G_j}{\sum_{j=1}^{m} C_j}$$

Where Cj = Number of credits allotted to a particular subject 'j'

Gj = Grade Point corresponding to the letter grade awarded to that subject 'j'

j = 1,2,….m represent the number of subjects of the entire program.

- Grade lower than D in any subject shall not be considered for CGPA calculation. The CGPA shall be awarded only when the student acquires the required number of credits prescribed for the program.

- **Grade Card**

The grade card issued shall contain the following:

a) The credits for each subject offered in that semester

b) The letter grade and grade point awarded in each subject

c) The SGPA/CGPA

d) Total number of credits earned by the student up to the end of that semester.

**7. Withholding of Results**

If the student has not paid dues to the Institute, or if any case of indiscipline is pending against him, the result of the student may be withheld and he shall not be allowed into the next higher semester. The award or issue of the provisional certificate and the degree may also be withheld in such cases. This delay shall not prejudice clauses Nos.6.0 and 6.1.

**8. Transitory Regulations**

Students who have discontinued or have been detained for want of attendance or any other academic requirements, may be considered for readmission as and when they become eligible. They have to take up Equivalent subjects, as substitute subjects in place of repeated subjects as decided by the Chairman of the BoS of the respective departments. He/She shall be admitted under the regulation of the batch in which he/she is readmitted.

**9. Minimum Instruction Days**

The minimum instruction days for each semester shall be **90 instruction days.**

**10. General**

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

**10.2** In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

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

**10.4** Wherever the words he, him or his occur, they shall also include she, her and hers.

**11. Supplementary Examination**

Supplementary examinations shall be conducted along with regular semester end examinations. (During even semester regular examinations, supplementary examinations of odd Semester and during odd semester regular examinations, supplementary examinations of even semester shall be conducted).

**VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**
**DEPARTMENT OF CIVIL ENGINEERING**

## Program Objectives and Outcomes for M. Tech. (Geotechnical Engineering)

### Program Education Objectives (PEOs)

1) To apply knowledge of geotechnical engineering to produce engineers to integrate and build concepts to improve professional leadership, teamwork, life-long learning, and career advancement.
2) To design and conduct experiments, to analyze and interpret data related to the geotechnical engineering, as well as to formulate systems within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3) To accentuate the understanding of the basic principles and exposes the student to the latest developments, with a strong research foundation so as to provide engineering solutions in a global, economic, environmental, and societal context.

### Program Outcomes (POs)

The program demonstrates that:

a. **Engineering Knowledge:** The graduates are capable of applying the core and multi-disciplinary knowledge for understanding the problems in Geotechnical engineering and related fields.
b. **Problem Analysis:** The graduates will possess critical thinking skills, problem solving abilities, familiarity with the computational procedures essential to the field, knowledge of various problems adhered to soil behaviour.
c. **Design & Development of Solutions:** The graduates are able to formulate, analyse, design and execute the construction of various types of foundations with appropriate consideration for public health and safety and cultural, societal and environmental conditions.
d. **Conduct investigations of complex problems:** The graduates can use research based knowledge and research methods to conduct experiments, to analyze and interpret experimental data.
e. **Modern Tool Usage:** The students get hands on training on various Geotechnical softwares and are able to model critical field problems using softwares.
f. **The Engineer and Society:** The students through the acquired appropriate knowledge can assess societal, health, safety, legal and cultural issues and will be able to take responsibilities relevant to Geotechnical Engineering practice.

g. **Environment and Sustainability:** As the students possess substantial knowledge in multi- disciplinary areas, one is able to plan the various projects well, keeping in view its environmental effects on other related fields.
h. **Ethics:** Apply ethical principles and commitment to professional responsibilities.
i. **Individual and Team work:** Capable of working efficiently as individual, as member or leader in driver set teams and in multi- disciplinary settings.
j. **Communication:** The students achieve excellence in expressing his/her ideas, writing technical reports with great communication skills and managerial skills.
k. **Project Management and Finance:** Graduates will be able to understand the critical issues in professional practice such as analyzing the critical soil conditions, procurement of works and the execution of a project and the financial managerial capabilities.
l. **Life-Long learning:** Students will maintain an awareness of contemporary issues and recognize the need for and engage in life-long learning to update with or develop technologies to meet the growing and changing needs of society

**VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY**
**DEPARTMENT OF CIVIL ENGINEERING**

**M.TECH. (GEOTECHNICAL ENGINEERING)**

**(R15 Regulation)**

**I Year I Semester** **COURSE STRUCTURE**

| Code | Group | Subject Name | L | T/P/D | Credits |
|---|---|---|---|---|---|
| GTE01 | **Core** | Advanced Soil Mechanics | 3 | 1 | 4 |
| GTE02 | | Advanced Foundation Engineering | 3 | 1 | 4 |
| GTE03 | | Soil Dynamics and Machine Foundations | 3 | 1 | 4 |
| GTE11 | **Elective - I & Elective – II Basket** | a) Ground Water Hydrology | 3 | 0 | 3 + 3 |
| GTE12 | | b) Geotechnical Aspects of Earth quake Engineering | 3 | 0 | |
| GTE13 | | c) Environment and Ecology | 3 | 0 | |
| GTE14 | | d) Ground water contamination and remediation | 3 | 0 | |
| GTE15 | | e) Geo-Environmental Engineering | 3 | 0 | |
| GTE16 | | f) Pavement analysis, Design & Material Characterization | 3 | 0 | |
| STR31 | **Open Elective – I** | a) Energy Efficient Buildings | 3 | 0 | 3 |
| MTH31 | | b) Computer Based Numerical Methods | 3 | 0 | |
| ENG32 | | c) Professional & Technical Communication | 3 | 0 | |
| GTE51 | **Lab** | Advanced Geotechnical Engineering Lab-1 | 0 | 3 | 2 |
| GTE61 | | Mini Project - I | 0 | 0 | 4 |
| | | **Total** | **18** | **6** | **27** |

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**DEPARTMENT OF CIVIL ENGINEERING**

**M.TECH. (GEOTECHNICAL ENGINEERING)**

**(R15 Regulation)**

**I Year II Semester** **COURSE STRUCTURE**

| Code | Group | Subject Name | L | T/P/D | Credits |
|---|---|---|---|---|---|
| GTE04 | **Core** | Retaining Structures | 3 | 1 | 4 |
| GTE05 | | Earth & Rock fill Dams and Slope Stability | 3 | 1 | 4 |
| GTE06 | | Engineering of Ground | 3 | 1 | 4 |
| GTE21 | **Elective - III & Elective – IV Basket** | a) Finite Element Methods | 3 | 0 | 3 + 3 |
| GTE22 | | b) Geographical Information Systems | 3 | 0 | |
| GTE23 | | c) Rock Mechanics and Engineering | 3 | 0 | |
| GTE24 | | d) Theoretical Soil Mechanics | 3 | 0 | |
| GTE25 | | e) Environmental Impact Assessment and Management | 3 | 0 | |
| GTE26 | | f) Geosynthetics and Soil Reinforcements | 3 | 0 | |
| STR41 | **Open Elective – II** | a) Optimisation Techniques in Engineering | 3 | 0 | 3 |
| HIG41 | | b) Construction Technology and Project Management | 3 | 0 | |
| GTE41 | | c) Ground Foundation and Structure Interaction | 3 | 0 | |
| GTE52 | **Lab** | Advanced Geotechnical Engineering Lab-II | 0 | 3 | 2 |
| GTE62 | | Mini Project - II | 0 | 0 | 4 |
| | | **Total** | **18** | **6** | **27** |

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**DEPARTMENT OF CIVIL ENGINEERING**

**M.TECH. (GEOTECHNICAL ENGINEERING)**

**(R15 Regulation)**

**II Year I Semester** **COURSE STRUCTURE**

| Code | Group | Subject Name | L | P | Credits |
|---|---|---|---|---|---|
| GTE63 | | Comprehensive Viva-Voce | - | - | 4 |
| GTE71 | | Internship/Dissertation Phase – I | - | - | 8 |
| | | **Total** | **0** | **0** | **12** |

**II Year I Semester** **COURSE STRUCTURE**

| Code | Group | Subject Name | L | P | Credits |
|---|---|---|---|---|---|
| GTE72 | | Internship/Dissertation Phase – II | - | - | 18 |
| | | **Total** | **0** | **0** | **18** |

**VNR Vignana Jyothi Institute of Engineering & Technology**

| **I Year- I Sem. M.Tech (Geotechnical Engineering)** | **L** | **T/P/D** | **C** |
|---|---|---|---|
| | **3** | **1** | **4** |

## (GTE01) ADVANCED SOIL MECHANICS

**Course Objectives:**

Student shall be able to

- **describe** the in-depth theoretical concepts pertaining to the mechanical behaviour of soil
- **identify** the various terminology and their applications in solving problems related to soil
- **differentiate** between the various stress states of the soil and their consequences
- **enable** the students to connect the knowledge gained to solve problems in the field

**Course Outcomes:**

After the completion of the course student should be able to

- **describe** different concepts and terms used in soil mechanics.
- **differentiate** between the various stress states to be applied for a given problem
- **predict** the kind of behavior expected from a given soil structure
- **identify** the appropriate formulae to be used due to the knowledge of the mechanics of soil

**UNIT I:**

**Geostatic Stresses & Stress Paths:** Stresses within a soil mass: Concept of stress for a particulate system, Effective stress principle, Geostatic stresses, Soil water hydraulics: Principal stresses and Mohr's circle of stress, Stress paths; At Rest earth pressure, Stress paths for different practical situations.

**UNIT II:**

**Flow through Soils:** Permeability, seepage, mathematical analysis – Finite difference formulae for steady state and transient flows – flow nets – computation of seepage – uplift pressure, and critical hydraulic gradient.

**UNIT III:**

**Compressibility and Consolidation:** One dimensional compression, Oedometer test, parameters – coefficient of volume change, constrained modulus, compression index, swell or unloading, maximum past consolidation stress, Over consolidation ratio, Primary and secondary compression, consolidation -One, two and three dimensional problems, Consolidation of partially saturated soils, Creep/Secondary Compression in soils.

**UNIT IV:**

**Stress-Strain-Strength Behaviour of Soils:** Shear strength of soils; Failure criteria, drained and undrained shear strength of soils. Significance of pore pressure parameters; Determination of shear strength; Drained, Consolidated Undrained and Unconsolidated Undrained tests; Interpretation of triaxial test results. Behaviour of sands; Critical void ratio; dilation in soils.

**UNIT V:**

**Critical State Soil Mechanics:** Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surfaces; Yielding, Bounding Surfaces.

**Text Books:**

1. Advanced Soil Mechanics by Das, B. M., Taylor and Francis, Third Edition
2. The Mechanics of Soils: An Introduction to Critical State Soil Mechanics by Atkinson by J.H. and Bransby, P.L., McGraw Hill, 1982

**References:**

1. An Introduction to the Mechanics of Soils and Foundation by Atkinson J. H., McGraw-Hill Co.,1993
2. Fundamentals of Soil Behaviour by Mitchell, J.K., Wiley, Third edition, 1993
3. Soil Behaviour and Critical State Soil Mechanics by Wood, D.M. 1999
4. Soil Mechanics by Craig, R. F., Van Nostrand Reinhold Co. Ltd., Seventh Edition
5. Soil Mechanics by Lambe, T. W. and Whitman, R. V., John Wiley & Sons, 2008

**VNR Vignana Jyothi Institute of Engineering & Technology**

| **I Year- I Sem. M.Tech (Geotechnical Engineering)** | **L** | **T/P/D** | **C** |
|---|---|---|---|
| | **3** | **1** | **4** |

## (GTE02) ADVANCED FOUNDATION ENGINEERING

**Course Objectives:**

Student shall be able to

- **create** ability to identify, formulates, and solve foundation engineering problems.
- **develop** an understanding of professional and ethical responsibility.
- **understand** the impact of engineering solutions in economic and environmental context.
- **create** an understanding to design and conduct experiments, as well as to analyze and interpret data relating to foundation engineering.

**Course Outcomes:**

After the completion of the course student should be able to

- **develop** an ability to apply knowledge of foundation engineering to solve problems related to geotechnical engineering.
- **design** a foundation system for economic and safe aspects for the society.
- **identify**, formulate and solve foundation related problems.
- **analyze** the soil settlement problems in Foundation Engineering.

**UNIT I:**

**Soil Exploration:** Exploration Methods; Planning the Exploration Program; Boring and Sampling; In Situ Tests: Standard & Cone Penetration Tests, Field Vane & Borehole shear tests, Dilatometer, Pressure meter; Rock Sampling, Core Recovery, RQD; Geophysical Exploration; Preparation of Soil Report

**UNIT II:**

**Shallow Foundations:** Bearing Capacity: General Formulae; Effect of Water Table; Footings with Eccentric or Inclined Loads, on Layered Soils, on slope and on top of the slopes, on finite layer with a Rigid Base at Shallow Depth, effect of compressibility of soil, on soils with strength increasing with depth.

**UNIT III:**

**Settlement:** Components – Immediate, Consolidation & Creep, Stresses and Displacements in Homogeneous, Layered and Anisotropic Soils; Consolidation Settlement; One, Two & Three Dimensional Consolidation; Secondary Compression Settlement; Bearing Pressure using SPT, CPT, Dilatometer and Pressure meter; Settlement of foundations on Sands Schmertmann and Burland & Busbridge methods; Structure Tolerance to Settlement and Differential Settlements, Rotation of Tall Structures.

**UNIT IV:**

**Deep Foundations:** Single Pile: Vertically loaded piles, Static capacity-$\alpha$, $\beta$ and $\lambda$ Methods, Dynamic formulae; Wave Equation Analyses; Point Bearing Resistance with SPT and CPT Results;

Bearing Resistance of Piles on Rock; Settlement; Pile Load Test; Uplift Resistance; Laterally Loaded Piles –Ultimate Lateral Resistance; Negative Skin Friction; Batter Piles; Under Reamed Piles; Mini and Micro Piles, Buckling of Fully and Partially Embedded Piles; Ultimate Capacity of Pile Groups in Compression, Pullout& Lateral Load; Efficiency; Settlements of Pile Groups; Interaction of Axially & Laterally Loaded Pile Groups.

**UNIT V:**

**Soil-Foundation-Structure Interaction:** Contact pressures and soil-structure interaction for shallow foundations; Concept of sub grade modulus; effects/parameters influencing sub grade modulus; Analysis of foundations of finite rigidity; Beams on elastic foundations; Analysis of raft foundations; Compensated Foundations.

**Text Books:**

1. Principles of Foundation Engineering, Das, B. M., Fifth Edition
2. Foundation Analysis & Design, Bowles, J. E., Fifth Edition

**References:**

1. Pile Foundation Analysis and Design Poulos, H. G. & Davis, E. H., 1980
2. Single Piles and Pile Groups under Lateral Loading, Reese, L. C. & Van Impe, W. F., Second Edition
3. Geotechnical & Geo-environmental Engineering Hand Book, Rowe, R. K., 1995
4. Foundation Design and Construction, Tomlinson, M. J., 2001
5. 3- Analysis and Design of Shallow and Deep Foundations, Reese, L. C. & Wang, S. T., 2006

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## (GTE03) SOIL DYNAMICS AND MACHINE FOUNDATIONS

**Course Objectives:**

Student shall be able to

- **introduce** the concept of dynamics and the various terminology encompassed in it.
- **explain** the behavior of the soil under dynamic loads.
- **teach** the difference between the conventional foundation behavior compared to influence of dynamic loads.
- **enable** the students to connect the knowledge gained to solve problems in the field

**Course Outcomes:**

After the completion of the course student should be able to

- **describe** various concepts and terminology involved in dynamic analysis of soil.
- **differentiate** between the conventional behavior and the behavior under dynamic loads for a given soil.
- **recognize** the importance of the due consideration given to design under dynamic loads.
- **design** the foundation which can tolerate dynamic loads (i.e. machine foundations).

**UNIT I:**

**Fundamentals of Vibration:** Definitions, Simple harmonic motion, Response of SDOF systems of Free and Forced vibrations with and without viscous damping, Frequency dependent excitation, Systems under transient loads, Rayleigh's method of fundamental frequency, Logarithmic decrement, Determination of viscous damping, Transmissibility, Systems with Two and Multiple degrees of freedom, Vibration measuring instruments.

**UNIT II:**

**Wave Propagation and Dynamic Soil Properties:** Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Elastic constants of soils, Correlations for shear modulus and damping ratio in sand, gravels, clays and lightly cemented sand. Liquefaction of soils: An introduction and evaluation using simple methods

**UNIT III:**

**Vibration Analyses:** Types, General Requirements, Permissible amplitude, Allowable soil pressure, Modes of vibration of a rigid foundation block, Methods of analysis, Lumped Mass models, elastic half space method, elasto-dynamics, effect of footing shape on vibratory response, dynamic response of embedded block foundation, Vibration isolation.

**UNIT IV:**

**Design of Machine Foundations:** Analysis and design of block foundations for reciprocating engines, Dynamic analysis and design procedure for a hammer foundation, IS code of practice

design procedure for foundations of reciprocating and impact type machines. Vibration isolation and absorption techniques.

**UNIT V:**

**Machine Foundations on Piles:** Introduction, Analysis of piles under vertical vibrations, Analysis of piles under translation and rocking, Analysis of piles under torsion, Design procedure for a pile supported machine foundation.

**Text Books:**


1. Handbook of Machine Foundations by Srinivasulu P., Vaidyanathan C.V., Tata McGraw-Hill Education, 1976.
2. Soil Dynamics and Machine Foundation, Swami Saran, Galgotia Publishing, 1999.


**References:**


1. Dynamics of Structures and Foundation, I. Chowdhary and S P Dasgupta, 2009.
2. Design of Structures and Foundations for Vibrating Machines, Arya, S. D, O'Neil, M. and Pincus, G., Gulf Publishing Co., 1979.
3. Foundation for Machines: Analysis and Design, Prakash, S. and Puri, V. K., John Wiley & Sons, 1998.
4. Soil Dynamics, Prakash, S., McGraw Hill, 1981.
5. Vibration Analysis and Foundation Dynamics, Kameswara Rao, N. S. V. , Wheeler Publication Ltd., 1998.

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## (GTE11) GROUND WATER HYDROLOGY
## (Elective-I / Elective-II)

**Course Objectives:**

Student shall be able to

- **create** an ability to apply knowledge of hydrology.
- **design** and **analyze** the problems related to the ground water.
- An **ability** to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- **describe** using the concepts of artificial recharge in ground water hydrology

**Course Outcomes:**

After the completion of the course student should be able to

- know the **critical** awareness of current issues in hydrology.
- **identify**, formulate and solve problems related to ground water
- **understand** the function on multidisciplinary teams.
- **design and implement** the recharge methods for artificial recharge of ground water.

**UNIT I:**

**Groundwater:** Groundwater hydrologic cycle. Origin of groundwater, quality of groundwater, vertical distribution of groundwater-zone of aeration and zone of saturation; Geologic formations as aquifers; types of aquifers, porosity, specific yield, specific retention; Permeability, Darcy's law, storage coefficient, Transmissibility.

**UNIT II:**

**Groundwater Flow:** Groundwater flow in one, two and three- dimensions; Groundwater flow contours and their applications; Steady groundwater flow towards a well in confined and unconfined aquifers- Dupuits' and Theism's equations, Formation constants, yield of an open well, interference and well tests; Unsteady flow towards a well – Non-Equilibrium equations – Theis's solution- Jacob and Chow's simplifications, Leaky aquifers.

**UNIT III:**

**Modeling and Analysis of Aquifer Systems:** Need, model calibration, single and multi-cell models, Inverse problems, estimation of regional aquifer problems; aquifer management; linear and non-linear programming methods.

**UNIT IV:**

**Investigations:** Surface methods of exploration - Electrical resistivity and seismic refraction methods. Subsurface methods; Geophysical logging and resistivity, logging; hydrologic maps; groundwater balance; contamination.

**UNIT V:**

**Artificial Recharge of Groundwater:** Concept of artificial recharge and recharge methods, relative merits, Saline water intrusion, Ghyben-Hergberg relation, shape of interface, control of sea water intrusion Surface methods of exploration - Electrical resistivity and seismic refraction methods. Subsurface methods; Geophysical logging and resistivity, logging; hydrologic maps; groundwater balance; contamination

**Text Books:**

1. Groundwater Hydrology, David K. Todd , John Wiley & Sons., New York, Third Edition, 2005
2. Hydraulics of Groundwater, Bear, J. , McGraw Hill, New York., 1979

**References:**

1. Groundwater, Raghunath, H. M., Wiley Eastern Ltd., 2006
2. Groundwater, Bauer, John Wiley & Sons

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## (GTE12) GEOTECHNICAL ASPECTS OF EARTHQUAKE ENGINEERING
## (Elective – I / Elective-II)

**Course Objectives:**

Student shall be able to

- **recognize** the importance of earthquake loads and its consequences on prebuilt geotechnical structures
- **understand** the various phenomena occurring during an earthquake and the mechanism of their failure
- **estimate** the susceptibility of a given size to an earthquake
- **analyze** the earthquake loads and their influence on the design of a structures

**Course Outcomes:**

After the completion of the course student should be able to

- **differentiate** between conventional loads and seismic loads and their effect on the structure
- **identify** the weak zones susceptible to earthquakes and take necessary precautionary measures Design safer and economical structures
- **identify, formulate and solve** foundation related problems
- **apply** the theoretical knowledge gained to solve real life problems in the field.

**UNIT I:**

**Earthquake Seismology:** Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.

**UNIT II:**

**Earthquake Ground Motion:** Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.

**UNIT III:**

**Ground Response Analysis:** One-dimensional ground response analysis: Linear approach, Nonlinear approach, Comparison of one dimensional ground response analyses. Two-dimensional ground response analysis: Dynamic finite element analysis, Equivalent linear approach, Nonlinear approach, Comparison of two dimensional ground response analyses.

**UNIT IV:**

**Liquefaction and Lateral Spreading** - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by

cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones. Soil improvement for remediation of seismic hazards.

**UNIT V:**

**Seismic Design of Foundations, Retaining Walls & Slopes** - Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement, Design loads. Seismic slope stability analysis - Internal stability and weakening instability, Seismic design of retaining walls: Dynamic response of retaining walls, Seismic displacement of retaining walls, Seismic design consideration.

**Text Books:**


1. Geotechnical Earthquake Engineering by Kramer S. L, Prentice Hall, 1996.
2. Geotechnical Earthquake Engineering Handbook by R. W. Day, McGraw-Hill, 2002.


**References:**


1. Seismic Behaviour of Ground and Geotechnical structure by Seco e Pinto, A. A. Balkema - 1997.
2. The Seismic Design Handbook by Naeim, F., Kluwer Academic Publication, 2nd Edition, 2001.
3. Earthquakes by Bolt, B. A., W. H. Freeman and Company, 4th Edition, 1999.
4. W. Fundamentals of Geophysics by Lourie, Cambridge University press, 1997.
5. Basic Geotechnical Earthquake Engineering by Kamalesh Kumar, New Age International Publishers, 1st Edition, 2008.

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## (GTE13) ENVIRONMENT AND ECOLOGY
## (Elective-I / Elective-II)

**Course Objectives:**

Student shall be able to

- **create** ability to identify, formulates, and solve environment related problems.
- **develop** an understanding of professional responsibility.
- **understanding** the impact of engineering solutions in economic and environmental context.
- **apply** the knowledge of recent environmental issues.

**Course Outcomes:**

After the completion of the course student should be able to

- **develop** an ability to apply knowledge of environment and ecology to solve problems
- **design** a process for economic and safe aspects for the society.
- **identify, formulate** and **solve** stability related problems.
- **identify** and **analyze** the recent environmental issues.

**UNIT I:**

**Environment**: Introduction, Components of Environment, types of Environment, Environmental Ethics

**Ecosystems:** Concept of an ecosystems, structure and functions of Ecosystem, producers, consumers and decomposers, energy flow and bio geo chemical cycles**.**

**UNIT II:**

**Ecological Succession Food Chains:** Food webs and ecological pyramids, types, characteristic feature structures and functions of eco system.

**UNIT III:**

**Human Population and Environment:** Population growth, variation among nations-Biotech potential and population growth, growth rate formula, carrying capacity, variation among nations, demographic transition, Developed and developing countries, Population explosion, consumption and affluence urbanization and environmental impacts, Industrialization and environmental impacts, family welfare program, immunization.

**UNIT IV:**

**Recent Environmental Issues:** Global warming , Global dimming Greenhouse gas ,Ocean acidification , Urban Heat Islands, Ozone depletion- CFC ,Biological effects of UV exposure,

**Nuclear Issues**: Nuclear fallout ,Nuclear meltdown , Nuclear power , Nuclear weapons , Nuclear and radiation accidents ,Nuclear safety ,High-level radioactive waste management.

**UNIT V:**

**Pollution:** Nonpoint source pollution, Point source pollution, Light pollution, Noise pollution, Visual pollution

**Water Pollution:** Acid rain, Eutrophication, Marine pollution, Ocean dumping, Oil spills, Thermal pollution, Effects and control

**Air Pollution:** Smog, Troposphere ozone, Indoor air quality, Volatile organic compound, Atmospheric particulate matter, Effects and control.

**Land Degradation:** Land pollution, Desertification, Soil conservation, Soil erosion, Soil contamination, Soil salination, Alkali soils.

**Text Books:**

1. Comprehensive Environmental Studies by Dr. JP Sharma, Laxmi Publications, 2009
2. Text Book of Environmental Studies by Dr. K. Raghavan Nambiar.

**References:**

1. Text Book of Environmental Studies by Kaushik, New Age Publishers, 2009
2. Environmental Science by Tyley Miller, Cengage Learning, Eleventh Edition, 2005
3. Concepts of Ecology by E.J. Kormondy, Prentice-Hall, 1969.

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## (GTE14) GROUND WATER CONTAMINATION AND REMEDIATION
## (Elective –I / Elective-II)

**Course Objectives:**

Student shall be able to

- **create** an ability to apply knowledge of engineering
- **design** and analyze the problems related to the ground water remediation.
- An **ability** to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- **develop** an understanding of professional and ethical responsibility.

**Course Outcomes:**

After the completion of the course student should be able to

- **understand** the function on multidisciplinary areas.
- **apply** the theoretical knowledge to solve real life problems.
- **inculcate** critical awareness of critical awareness of current issues in remediation techniques
- **identify**, **formulate** and **solve** problems for the environment, society and economic viability.

**UNIT I:**

**Introduction:** Sources and types of groundwater contamination, Characterization of contaminated site, Contaminant transport mechanisms.

**UNIT II:**

**Sorption and Other Chemical Reactions:** Introduction, concept of sorption, factors influencing sorption, sorption isotherms, hydrophobic theory for organic contaminants, sorption effects on fate and transport of pollutants, Estimation of sorption.

**UNIT- III**

**Flow and Transport in the Unsaturated Zone:** Capillarity, soil, water characteristics curves, unsaturated hydraulic conductivity, governing equation for unsaturated flow, measurement of soil properties.

**UNIT- IV**

**Non, Aqueous Phase Liquids:** Introduction, Types of NAPLs, NAPL transport, General processes, NAPL transport, computational methods, Fate of NAPLs in the subsurface, characterizing NAPLs at remediation sites.

**UNIT- V**

**Groundwater Remediation Technologies** – Methods of remediation of contaminated ground, pump and treat, insitu flushing, permeable reactive treatment walls, air sparging, soil vapour extraction, natural attenuation, bioremediation and phytoremediation.

**Text Books:**

1. Groundwater Contamination (Transport and remediation) by Bedient, Rifai & Newell, Prentice Hall PTR, Second Edition, 1999
2. Geotechnical & Geoenvironmental Engineering Handbook by Rowe, R. K., Springer US, 2001.

**References:**

1. Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies by Sharma H.D. and Reddy K.R , John Wiley & Sons, Inc., USA, 2004.
2. Geoenvironmental Engineering, Principles and Applications by Reddi L.N. and Inyang, H. I Marcel Dekker Inc. New York, 2000
3. Geotechnical Practice for Waste Disposal by Daniel, D. E., Springer Science & Business Media, 2012

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## (GTE15) GEO-ENVIRONMENTAL ENGINEERING
## (Elective-I / Elective-II)

**Course Objectives:**

Student shall be able to

- To **introduce** traditional curriculum consisting mostly of practical courses in numerous special aspects of soil engineering.
- To **accentuate** the understanding of the basic principles and exposes the student to the latest developments, with a strong research orientation.
- To **mould** the students with broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- To **understand** the various remediation techniques for solving the Geo-Environmental problems

**Course Outcomes:**

After the completion of the course student should be able to

- **understand** the function on multidisciplinary teams.
- inculcate **critical** awareness of current issues in Geotechnical Engineering.
- **improvise** techniques, skills, and modern engineering tools necessary for successful career in geotechnical engineering practice.
- **describe** and **implement** the remediation techniques in Geo-Environmental Engineering.

**UNIT I:**

**Sources and Site Characterization:** Scope of geoenvironmental engineering - multiphase behavior of soil – role of soil in geoenvironmental applications – importance of soil physics, soil chemistry, hydrogeology, biological process – sources and type of ground contamination – impact of ground contamination on geoenvironment - case histories on geoenvironmental problems.

**UNIT II:**

**Solid and Hazardous Waste Management:** Identification and Classification of waste, Solid Waste management: Generation-Storage and collection -Transfer and Transport - processing and Disposal, Characterization solid wastes, Environmental Concerns with waste, Hazardous Waste management-Disposal Techniques.

**UNIT III:**

**Contaminant Transport:** Soil mineralogy characterization and its significance in determining soil behavior – soil-water interaction and concepts of double layer – forces of interaction between soil particles .Transport process, Mass-transfer process, Modeling, Bioremediation, and Phytoremediation

**UNIT IV:**

**Remediation Techniques:** Site characterization – risk assessment of contaminated site - remediation methods for soil and groundwater – selection and planning of remediation methods – some examples of in-situ remediation., various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies.

**UNIT V:**

**Landfills:** Definition- Landfilling of Municipal Solid Waste- Environmental Impact and its minimization, Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system.

**Text Books:**


1. Geotechnical & Geo-environmental Engineering Handbook by Rowe, R. K., Springer US, 2001.
2. Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies by Sharma H.D. and Reddy K.R , John Wiley & Sons, Inc., USA, 2004.


**References:**


1. Groundwater Contamination (Transport and remediation) by Bedient, Rifai & Newell, Prentice Hall PTR, Second Edition, 1999
2. Geoenvironmental Engineering by Reddi, L. N. and Inyang, H. I., Marcel Dekker Inc. New York, 2000.
3. Hazardous Waste Management. By LaGrega, M. D., Buckingham, P. L. and Evans, J. C., waveland Press Inc., Second Edition, 2010

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## (GTE16) PAVEMENT ANALYSIS, DESIGN & MATERIAL CHARACTERIZATION (Elective-I/II)

**Course Objectives:**

- To **apply** the basic knowledge of mathematics in engineering.
- To **provide** a formidable base for analysis and programming using computer applications.
- To **develop** the ability in programming and solutions based on the various analysis tools.
- To **describe** the various types of pavements with suitability.

**Course Outcomes:**

On successful completion of this course, it is expected that students should be able to

- **learn** how to apply it to basic (linear) ordinary and partial differential equations.
- **identify** mathematical model for solution of common engineering problems.
- **formulate** simple problems into programming models.
- **select** the type of pavement based on the soil conditions

**UNIT I:**

**Road Pavements and Pavement Layers:** Types, Functions, Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL,VDF due to varying loads, Sub grade support - CBR and plate bearing tests.

**UNIT II:**

**Stresses and Deflection / Strain in Flexible Pavements:** Application of elastic theory, stresses, deflections / strains in single, two and three layer system, Applications in pavement design, Problems.

**UNIT III:**

**Flexible Pavement Design:** Empirical, Semi empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems.

**UNIT IV:**

**Stresses and Design of Rigid Pavements**: Types of stresses and causes; Introduction to Westergaard's equation for calculation of stresses in rigid pavements due to wheel loads and temperature; Considerations in rigid pavement analysis, wheel load stresses, warping stresses, frictional stresses, combined stresses.

**Design of Cement Concrete Pavements for Highways as per IRC Guidelines.**

**UNIT V:**

**Pavement Material and Construction Aspects**: Highway materials – properties and tests on soil, Aggregate and bitumen. Construction of earthen roads, Gravel roads, WBM roads. Objectives and Soil stabilization- methods – soil cement stabilization and soil lime stabilization.

**References**:


1. Principles of Pavement Design by Yoder and Witczak, John Wiley and sons Inc, Second Edition, 1975
2. Highway Engineering by S.K. Khanna and Justo, NemChand & Bros. Roorkee.
3. Design of functional Pavements by YC Yang, , McGraw Hill Book Co., 1993
4. Pavement Analysis, Huang by Pearson Education India, 2008
5. Design & Performance of Road Pavements by David Croney and Paul Croney, McGraw hill Book Co., 1997
6. Modern Pavement Management by W.Ronald Hudson, Ralph Haas and Zeniswki, Krieger Pub. Co., 1994
7. IRC 37,2001, IRC 81,1997, IRC 58 – 2002, IRC 59 – 1976, IRC 101,1988

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## (MTH31) COMPUTER BASED NUMERICAL METHODS
## (Open Elective - I)

**Course Objectives:**

**Student shall be able to**

- **apply** the basic knowledge of mathematics in engineering.
- **provide** a formidable base for analysis and programming using computer applications.
- **develop** the ability in programming and solutions based on the various analysis tools.
- **solve** the Linear Programming problems related to Engineering.

**Course Outcomes:**

After the completion of the course student should be able to

- **apply** it to basic (linear) ordinary and partial differential equations.
- **identify** mathematical model for solution of common engineering problems.
- **formulate** simple problems into programming models.
- **apply** and **solve** the Linear Programming problems using Algorithms.

**UNIT I:**

**Solution of Algebraic and Transcendental Equations:** Introduction, errors and approximations, binary and decimal systems, computing roots using direct methods (bisection, regulafalsi) and Iterative Methods (fixed point iterative and Newton-Raphson Methods) and applications Lab: Implementation of algorithms on computers using any computer language and comparison (Bisection and N-R Method).

**UNIT II:**

**Solution of Simultaneous Linear Equations:** Introduction, Methods of solution direct (Matrix inversion and Gauss elimination methods) and iterative methods (Gauss Jacobi and Gauss seidel methods) disadvantages of ill-conditioned systems and pivoting, eigen value, computing largest Eigen value by power method and applications Lab: Implementation of algorithms on computers and comparison.

**UNIT III:**

**Interpolation, Numerical Differentiation and Integration:** Introduction, Interpolation for equally spaced data and unequally spaced data by Newton's methods, Lagrange's method and cubic splices. Numerical differentiation formulae using finite differences and interpolation. Newton-Cotes integration formulae (Trapezoidal and Simpsons rules) and Gauss quadrature formulae and applications. Lab: Implementation of algorithms on computer (Newton's formula, Trapezoidal and Simpsons rule).

**UNIT IV:**

**Numerical Solutions of Differential Equations (ODE & PDE):** Introduction, solution of ODE of IVP type by Euler's methods, Runge-Kutta methods (single step) and multistep methods. Numerical solution of PDE using finite difference schemes approach, (Parabolic, Elliptic type) and applications Lab: Implementation of R-K method (for ODE) Bender Schmidt and Crank- Nicolson methods (for PDE).

**UNIT V:**

**Linear Programming Problems (LPP):** Introduction, formation of LPP, methods of solution. Graphical method, simplex methods, dual simplex method, artificial variables, Big-on method, Transportation problems (by VAM) and applications. Lab: Implementation of Simplex algorithm.

**References:**


1. Numerical Methods by Dr.B.S.Grewal, Khanna Publishers.
2. Numerical Analysis by R.L.Burden & J.D.Faires, International Thomson Publishing; Fourth Edition 1991
3. Numerical Methods for Engineers by Chopra S.C and Canale R.P, Tata McGraw-Hill, Fourth Edition, 2002
4. Numerical Methods for scientific and Engineering by Iyenger & Jain, New Age International Publishers, Sixth Edition, 2005

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## (ENG32) PROFESSIONAL AND TECHNICAL COMMUNICATION
## (Open Elective-I)

**Introduction:**
This course aims to offer students a practical approach to professional and technical communication; and to focus specifically on verbal and written communication. Additionally, the course is designed to build confidence and; group communication and public speaking competence. Each unit in the syllabus is devised so as to include a writing component as well as an oral component.

**Course Objectives:**
- To enable the students to write without errors in spelling, mechanics, grammar and punctuation; resume, business letters, proposals and reports to accomplish academic as well as professional goals.
- To train students to write clearly, cohesively, emphatically and concisely.
- To groom students to speak accurately and fluently and prepare them for real world activities
- To train students in soft skills through group discussion to improve their EQ.

**Course Outcomes:**
Students will be able to:
- analyze communication situations and audiences to make choices about the most effective and efficient way to communicate and deliver messages
- write resume, business letters, project proposals and reports
- speak fluently and address a large group of audience and participate in discussions.
- navigate through complex environments through interpersonal and collaborative skills.

**UNIT I:**
- Oral Communication :Self-introduction
- Applications and Covering letters
- Resume Writing
- Job Interviews

**UNIT II:**
- Oral Communication: Impromptu Speech
- Reading Business and Technical Texts
- Writing E-mails
- Writing Business Letters and Business Memos

**UNIT III:**
- Oral Communication: Group Discussions
- Summarizing and Synthesizing
- Writing Abstracts

**UNIT IV:**

- Oral Communication : Debate
- Writing Business Proposals
- Writing Technical Proposals

**UNIT V:**

- Oral Communication: Making Presentations
- Interpreting Graphic Information
- Writing Business Reports
- Writing Technical Reports

**Text and Materials:**

1. Ashraf Rizvi, M (2005). Effective Technical Communication, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. M. Raman and S. Sharma, Technical Communication: Principles and Practices, OUP, 2004. (Indian Edition)

**References:**


1. William S. Pfeiffer, (2012) Technical Communication: A Practical Approach (7th Ed.) Longman
2. Burnett, Rebecca. Technical Communication. 5th Ed., Heinle, 2001.
3. Gerson Sharon J. and Steven Gerson: Technical Writing Process and Product. 3rd edition, New Jersey: Prentice Hall 1999
4. Markel, Mike**.** Technical Communication: Situations and Strategies (8th EDITION (2006-2007)
5. R. C. Sharma and K. Mohan, Business Correspondence and Report Writing, Third Edition, TMH, 2002. (Indian Edition)
6. Anderson, Paul V. (2003). Reports. In Paul V. Anderson's Technical Communication: A Reader-Centered Approach (5th Ed.) (pp. 457-473). Boston: Heinle.

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## (STR31) ENERGY EFFICIENT BUILDINGS
## (Open Elective - I)

**Course Objectives:**

Student shall be able to

- **study** the design of energy efficient buildings which balances all aspects of energy, lighting, space conditioning and ventilation.
- **learn** passive solar design strategies.
- **understand** the use of materials with low embodied energy.
- **design** the standards for ventilation and different climatic zones

**Course Outcomes:**

After the completion of the course student should be able to

- **Design** energy efficient buildings which balance all aspects of energy, lighting, space conditioning and ventilation.
- **Design** energy efficient buildings with passive solar design strategies.
- **Use** materials with low embodied energy.
- **Apply** concepts in Energy auditing

**UNIT I:**

**Introduction:** Energy required for building construction - Heat Transfer – Measuring Conduction – Thermal Storage – Measurement of Radiation – The Green house Effect – Psychrometry Chart – Measuring latent and sensible heat. Thermal Comfort – Site Planning and Development – Temperature – Humidity – Wind – Optimum Site Locations – Sun Protection – Types of Shading Devices – Conservation – Heating and Cooling loads.

**UNIT II:**

**Passive Solar Heating and Cooling:** General Principles of passive Solar Heating – Key Design Elements - Direct gain Trombe Walls, Water Walls, Convective Air loops – Concepts – Case Studies – General Principles of Passive Cooling – Ventilation – Predicting ventilation in buildings – window ventilation calculations - Radiation – Evaporation and dehumidification – Mass Effect – Load Control – Air Filtration and odor removal – Heat Recovery in large buildings

**UNIT III:**

**Daylighting and Electrical Lighting:** Materials, components and details - Insulation – Optical materials – Radiant Barriers Glazing materials - Day lighting – Sources and concepts – Building Design Strategies –Case Studies – Electric Lighting –Light Distribution – Electric Lighting control for day lighted buildings – Illumination requirement – Components of Daylight factor – Recommended Daylight factors – Day lighting analysis – Supplementary Artificial Lighting Design

**UNIT IV:**

**Heat Control and Ventilation:** Requirements – Heat transmission through building sections – Thermal performance of Building sections – Orientation of buildings – Building characteristics for various climates – Thermal Design of buildings Influence of Design Parameters – Mechanical controls –Examples. Ventilation – Requirements – Minimum standards for ventilation – Ventilation Design – Energy Conservation in Ventilating systems – Design for Natural Ventilation.

**UNIT V:**

**Design for Climatic Zones:** Energy efficiency – an overview of design concepts and architectural interventions –Energy efficient buildings for various zones – cold and cloudy – cold and sunny – composite – hot and dry – moderate – warm and humid – case studies of residences, office buildings and other buildings in each zones – Energy Audit – Certification

**Text Books:**

1. Energy – efficient Buildings in India by Majumdar, M. (Ed), Tata Energy Research Institute, Ministry of Non Conventional Energy Sources, 2002.
2. Handbook on energy audits and management Tata Energy Research by Tyagi, A. K.(Ed),

**References:**

1. Environmental Control System by Moore, F., McGraw Hill Inc., 2002
2. Sun, Wind and Light – Architectural Design Strategies by Brown, G.Z. and DeKay, M., John Wiley and Sons Inc, 2001

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## (GTE51) ADVANCED GEOTECHNICAL ENGINEERING LAB – I

**Course Objectives:**

Student shall be able to

- **know** the concepts of various types of soils.
- **introduc**e traditional program consisting mostly of practical courses related to geotechnical engineering.
- **apply** the knowledge of science, mathematics and engineering with the context of applications in geotechnical engineering
- conduct experiments, **analyze** and interpret data related to the various laboratory tests studied in geotechnical engineering.

**Course Outcomes:**

After the completion of the course student should be able to

- **identify** the various types of soils existing at the site.
- **use** the techniques, skills, and modern engineering tools necessary for engineering practice.
- **predict** probable problems that may be encountered in any project.
- **identify, formulate** and **solve** geotechnical engineering related issues.

**List of experiments**

1. Grain size analysis – wet sieve analysis (IS: 2720 (Part 4) – 1985)
2. Hydrometer Analysis. (IS: 2720 (Part 4) – 1985)
3. Consistency Limits-Cone Test for Liquid Limit. (IS: 11196 – 1985)
4. Proctor Compaction Test. (IS: 2720 (Part 7) – 1985)
5. Permeability of Clay Soils. (IS: 2720 (Part 17) – 1985)
6. Free Swell, Swell Potential, Swell Pressure Test. (IS: 2720 (Part 40) – 1985)
7. Oedometer Test. (IS: 2720 (Part 15) – 1985)
8. California Bearing Ratio test. (IS: 2720 (Part 16) – 1985)
9. Standard Penetration Test. (IS: 2123 - 1981)
10. Cone Penetration Test (IS: 4968.3 - 1976)

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## (GTE61) MINI PROJECT - I

A mini project work shall be carried out on any topic of Geotechnical Engineering and a seminar should be given on the same along with a brief report.

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## (GTE04) RETAINING STRUCTURES

**Course Objectives:**

Student shall be able to

- **describe** the theoretical concepts considered design of retaining structures.
- **explain** and arrive at the design methodology prescribed for various retaining structures
- **enable** the students to identify the kind of retaining structure required to serve the design purpose adequately
- **enable** the students to connect the knowledge gained to real life hydrology problems

**Course Outcomes:**

After the completion of the course student should be able to

- **to describe** different concepts and terms used in retaining structures.
- to **discuss** and explain various formulas used and the design procedures of different retaining structures.
- to **relate** and explain the effectiveness of any kind of retaining structure for a given situation.
- to **design** the retaining structures using the appropriate methodology and formulas.

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**UNIT I:**

**Earth Pressure Theories:** Rankine's and Coulomb's Earth pressure theories for cohesive and cohesion less soils, Static and Seismic analysis, Stresses due to compaction and surcharge loads.

**UNIT II:**

**Conventional Retaining Wall:** Types of retaining walls, Stability (sliding, overturning, bearing Capacity & overall) of gravity and cantilever walls, Proportioning of retaining walls, Backfill material and drainage.

**UNIT III:**

**Flexible Walls:** Sheet pile walls, Construction methods-Cantilever and Anchored sheet pile wall.

**UNIT IV:**

**Reinforced Soil Walls/Mechanically Stabilized Earth:** Failure mechanisms bond and rupture failures, Analysis methods, Limit equilibrium method-Internal and external stability, Static and seismic analyses.

**UNIT V:**

**Braced Cuts and Soil Nailing:** Lateral earth pressure in braced cuts, Design of various components, Stability of braced cuts, base heave and stability, yielding and settlement of ground Surrounding excavation, Diaphragm walls –slurry support; Soil Nailing..

**Text Books:**

1. Principles of Foundation Engineering by Das, B. M, Cengage Learning, Eighth Edition, 2015
2. Foundation Analysis & Design by Bowles. J. E., McGraw-Hill, Fifth Edition, 2001

**References:**

1. Foundation Engineering Handbook by Rowe, R. K, Springer Science & Business Media, 2001.
2. Foundation Engineering Handbook by Winterkorn and Fang, Springer Science & Business Media, 2013

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## (GTE05) EARTH & ROCKFILL DAMS AND SLOPE STABILITY

**Course Objectives:**

Student shall be able to

- **inculcate** the ability to identify, formulate and solve soil stability related problems.
- **differentiate** between the various kinds of structures depending upon its composition and usage
- **impart** the ability to design soil slopes and dams without leading to failure
- **recognize** the importance of various hazards involved in building slopes and dams and to take up suitable precautions or repairs

**Course Outcomes:**

After the completion of the course student should be able to

- **identify** the appropriate formulae to be used in the design of various structures
- **analyze** a given structure and predict its behavior
- **design** a dam/slope with high efficiency
- **connect** the knowledge gained to solve problems in the field

**UNIT I:**

**Earth and Rockfill Dams**: General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Materials of construction and requirements, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Inclinometers, Stress measurements, seismic measurements.

**UNIT II:**

**Failures, Damages and Protection of Earth Dams**: Nature and importance of failure, Piping through embankment and foundations, Methods of seepage control through embankments and foundations, Design Criteria for filters, Treatment of upstream and downstream of slopes, Drainage control, Filter design.

**UNIT III:**

**Slope Stability Analysis**: Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes.

**UNIT IV:**

**Methods of Slope Stability**: Taylor Charts, Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Noncircular Failure Surfaces: Morgenstern and Price Analysis, Janbu Analysis, Spencer Analysis, Sliding Block Analysis, Seismic stability, Stabilization of slopes: Drainage measures, Soil reinforcement (geosynthetics/soil

nailing/micro piles etc), soil treatment (cement/lime/thermal treatment), surface protection (vegetation/erosion control mats/shotcrete).

**UNIT V:**

**Rockfill Dams:** Types and Historical development, General characteristics of Rock fill dams, Requirements of compacted rock fill, materials for the Rock fill dams, Shear strength of rock fill, Settlement for Rock fill dams, Movements in rock fill dams.

**Text Books:**


1. Earth and Earth Rock Dams by Sherard, John Wiley, 1967
2. Earth and Rockfill Dams by Sowers, G. F. and Salley, H. I, Asia Pub. House, 1962


**References:**


1. Earth and Rockfill Dams by Bharat Singh and Sharma, H. D, Central Board of Irrigation and Power, 1986
2. Slope Stability and Stabilization methods by Abramson, L. W., Lee, T. S. and Sharma, S., John Wiley & sons., Second Edition
3. The Stability of Slopes by Bromhead, E. N.., Blackie academic and professional, London Second Edition, 1992.
4. Earth & Rockfill Dams –Principles of Design and Construction by Christian, Kutzner, Oxford and IBH,1997
5. Handbook of Slope Stabilization by Ortiago, J. A. R. and Sayao, A. S. F. J., Springer Berlin Heidelberg, 2004.

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## (GTE06) ENGINEERING OF GROUND

**Course Objectives:**

**Student shall be able to**

- **know** the need and objectives of ground improvement techniques.
- **comprehend** the principles of various ground improvement methods
- **compare** different methods of ground improvement and understand their suitability.
- **apply** the relevant method to remedy a difficult soil condition.

**Course Outcomes:**

After the completion of the course student should be able to

- **Apply** the principles of ground improvement to a given site condition
- Work out the choice of right technique to **improve** different difficult grounds
- Ensure safe, stable and economical **construction** for any structure.
- Learn the issues affecting **design** and construction of various methods for soil improvement

**UNIT I:**

**Introduction to Ground Modification**: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement.

**UNIT II:**

**Mechanical and Hydraulic Modification**: Methods of compaction, Shallow compaction, Deep compaction techniques - Vibro-floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control.; Hydraulic Modification: Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

**UNIT III:**

**Physical and Chemical modification**: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

**UNIT IV:**

**Soil Confinement Systems**: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric Formwork. Miscellaneous Techniques: Design, Construction and applications of stone columns, lime columns.

**UNIT V:**

**Modification by Inclusions and Confinement**: In-Situ ground reinforcement, ground anchors, rock bolting and soil nailing. Thermal modification, Ground freezing. Filtration, Drainage and seepage control with Geosynthetics.

**Text Books:**

1. Engineering Principles of Ground Modifications by Hausmann, M. R., McGraw Hill Publications, 1990
2. Designing with Geosynthetics by Koerner, R. M, Prentice Hall, New Jersey, 1994

**References:**

1. Earth Reinforcement and soil structures by Jones C. J. F. P., Butterworths, London. 1985
2. Ground Control and Improvement by Xianthakos, Abreimson and Bruce, John Wiley & Sons, 1994
3. Ground Improvement by Mosley, CRC Press, Second Edition, 2004
4. Engineering with Geosynthetics by C.V.J. Varma, A.R.G. Rao, *G.V. Rao.* Divan enterprises, New Delhi, 1995.

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## (GTE21) FINITE ELEMENT METHODS
## (Elective – III / Elective- IV)

**Course Objectives:**

Student shall be able to

- **develop** the student's skills in applying the basic matrix operation to form a global matrix equation and enforce the concept of steps in obtaining solutions for 1-D structures.
- **develop** the student's skills in applying the interpolation functions to solve bar, beam problems.
- **provide** the student with some knowledge and analysis skills in forming basic data required in a FEM computer program.
- **impart** the knowledge of the basics behind the complicated Finite Element Analysis Software.

**Course Outcomes:**

After the completion of the course student should be able to

- **apply** the basic (linear) ordinary and partial differential equations.
- **implement** the finite element method efficiently in order to solve field problems.
- **identify** mathematical model for solution of common engineering problems.
- **differentiate** between the various elements available in Finite Element Software's and their applicability appropriately

**UNIT I:**

**Introduction:** Concepts of FEM, Steps involved in Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Stress equations, Strain- Displacement relationships in matrix form, Plane stress, Plane strain and axisymmetric bodies of revolution with axisymmetric loading.

**UNIT II:**

**Element Properties**: Concept of an element, various element shapes, displacement models, generalized coordinates, Shape functions, Convergent and Compatibility requirements, geometric invariance, Natural coordinate system - area and volume coordinates.

**UNIT III:**

**Generation of Element Stiffness and Nodal Load Matrices, Isoparametric Formulation**: Concept, Different isoparametric elements for 2D analysis, formulation of 4-noded and 8-noded isoparametric quadrilateral elements, Lagrangian elements, Serendipity elements.

**UNIT IV:**

**Assemblage of Elements:** Discretization of a structure, numbering systems, Aspect ratio its effects, Assemblage, Direct Stiffness method.

**UNIT V:**

**Geotechnical Applications:** Sequential construction, Excavations and embankments, Bearing capacity and Settlement analysis.

**Text Books:**

1. Introduction to Finite element Method by Desai, C. and Abel, CRC Press, 2001
2. Finite element Methods by Zienkiewicz, O. C., Butterworth-Heinemann, Fifth Edition, 2000

**References:**

1. Finite element analysis - Theory and programming by Krishna Murthy, C. S. Tata McGraw-Hill Education, 1995

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## (GTE22) GEOGRAPHICAL INFORMATION SYSTEM
## (Elective-III / Elective-IV)

**Course Objectives:**

Student shall be able to

- **describe** and **define** various concepts of Remote Sensing and GIS.
- enable the students to **analyze** Remote sensing and GIS data.
- make the students **appraise** the importance accuracy of remote sensing and GIS data
- enable the students to **apply** Remote Sensing and GIS knowledge in solving various Geotechnical engineering related problems.

**Course Outcomes:**

After the completion of the course student should be able to

- **describe** different concepts and terms used in Remote Sensing and GIS.
- **compare** and process different data sets.
- **evaluate** the accuracy and **decide** whether a data set can be used or not.
- **demonstrate** various applications in RS and GIS.

**UNIT I:**

**Remote Sensing:** Introduction- Principle of remote sensing, components of remote sensing, Remote sensing platforms, Radiometric quantities, Electromagnetic radiation and its properties, Electromagnetic energy laws, Interaction of EMR with earth features, Interaction of EMR with atmospheric features, atmospheric effects on remote sensing data, spectral reflectance curves, Spectral properties of soil, water, vegetation. Advantages and Disadvantages of Remote Sensing Data.

**UNIT II:**

**Satellites and Sensors:** Sensors - Remote sensing sensors types, Along track scanners, Across track scanners Sensor Characteristics – Swath, IFOV, Nadir view, Spatial Resolution, Spectral Resolution, Temporal, Resolution, Radiometric resolution, Atmospheric, Radiometric, Geometric corrections

**Satellites –** Satellite orbits, Geostationary and polar satellites, various satellites and their main applications, IRS satellites

**UNIT III:**

**Remote Sensing Data Interpretation, Processing and Enhancement:** Elements of visual interpretation, Image enhancement techniques - necessity and importance, contrast enhancement techniques, low pass (smoothing) filters and high pass (sharpening) filters, linear and non-linear filtering techniques, edge detection, supervised classification, unsupervised classification, and Classification accuracy. Introduction to GPS and DGPS.

**UNIT IV:**

**Geographical Information System:** Introduction, Definition and Terminology, Components of GIS, GIS Data Input - Keyboard entry, Manual digitizing, Scanning methods, Errors in digitizing, Data output formatting and output devices, GIS Data Models – Raster, Vector, TIN, Spatial Data Analysis – Interpolation, Buffering techniques, Overlay operations

**UNIT V:**

**Applications of GIS in Geotechnical Engineering:** Developing a Soil information system for Multiple decisions, GIS and Remote Sensing based Soil mapping, Soil moisture investigation, land slide hazard zonation using remote sensing and GIS, Landuse land cover classification, Agriculture applications, Dam site selection using RS and GIS

**Text Books:**


1. Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W.Kiefer, John Wiley & Sons, Seventh Edition 2014
2. Remote Sensing and GIS by Basudeb Bhatta , Oxford University Press, 2008


**References:**


1. Introduction to Geographic Information systems by Kang-tsung Chang, McGrawHill Education (Indian Edition). Seventh Edition, 2013
2. Basics of Remote sensing and GIS by Dr.S.Kumar, Laxmi Publications, 2005
3. Textbook of Remote Sensing and Geographical Information systems by M.Anji Reddy, B.S.Publications, Third Edition 2008
4. Textbook of Remote Sensing and Geographical Information systems by Kali Charan Sahu, Atlantic Publishers and Distributors, Atlantic Publishers & Dist, 2007

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## (GTE23) ROCK MECHANICS AND ENGINEERING
## (Elective- III / Elective-IV)

**Course Objectives:**

Student shall be able to

- **introduce** the concepts of Rock Mechanics and various terminology involved.
- **design** and conduct experiments, as well as to analyze and interpret data related to the rock mechanics.
- **impart** the understanding of the basic principles and exposes the student to the latest developments and applications.
- **enable** the students to connect the theoretical knowledge gained to real life problems.

**Course Outcomes:**

After the completion of the course student should be able to

- **apply** Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in Rock mechanics.
- **relate** to the latest trends, modern standards and state-of-the-art techniques for understanding rock mechanics and engineering.
- **understand** the functions on multidisciplinary teams.
- **predict** the mode of failure of Rock Structures and to implement appropriate preventive measures.

**UNIT I:**

**Engineering Classification of Rocks**: 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, Geoengineering classification.

**UNIT II:**

**Laboratory and In-Situ Testing of Rocks:** 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:** 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, Viscoelastic, Elasto-viscoplastic stress-strain models

**UNIT IV:**

**Stability of Rock Slopes and Foundations on Rocks:** 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 Excavations:** Blasting operational planning, Explosive products, Blast Design, Underground blast design, Controlled blasting techniques, blasting damage and control, Safe practice with explosives and shots.

**Text Books:**


1. Introduction to Rock mechanics by Goodman, Wiley, Second Edition 1989
2. Engineering in Rocks for slopes, foundations and tunnels by Ramamurthy, T., Prentice Hall of India, PHI Learning Pvt. Ltd., Third Edition 2014


**References:**


1. Fundamentals of Rock Mechanics by Jaeger, J. C. and Cook, N. G. W, Chapman and Hall, London. Third Edition, 1979
2. Underground Excavation in Rock by Hoek, E. and Brown, E. T, 1982.
3. Rock Mechanics for Underground Mining by Brady, B. H. G. and Brown, E. T., Chapman & Hall, Springer Science & Business Media, Third Edition, 2007

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## (GTE24) THEORETICAL SOIL MECHANICS
## (Elective- III / Elective-IV)

**Course Objectives:**

Student shall be able to

- **introduce** the concepts of elasticity and plasticity and their applications in Soil Mechanics
- **develop** an understanding to function on multidisciplinary areas.
- **create** ability to identify, formulates, and solve foundation engineering problems.
- **understand** the effect of various loads on soil moment and subsequent design considerations.

**Course Outcomes:**

After the completion of the course student should be able to

- **Identify**, **formulate** and **solve** geotechnical engineering problems through an understanding of theory of Soil mechanics.
- **Differentiate** between the types of displacements and their applicability to the given structure
- **Relate** techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.
- **Understand** the professional and ethical responsibility.

**UNIT I:**

**Theory of Elasticity**: Basic concepts, definitions and notations of stress & strain components – Generalized Hooke's Law, Equilibrium and Compatible conditions in Cartesian, Polar coordinates – Principal stresses and strains – octahedral stresses – stress invariants.

**UNIT II:**

**Theory of Plasticity**: Ideal Plastic substance strain hardening – yield criteria – Tresca, & Van Mises, Mohr & Coulomb, Drucker-Prager theories, Critical State Soil Mechanics, – applications to soil mechanics problems.

**UNIT III:**

**Stresses and Displacements due to Surface and Subsurface Loads** – Boussinesq, Cerutti, Mindlin Solutions, Stresses and Displacements in Finite Layer & Multi- Layered Systems and Anisotropic and Non-homogeneous Elastic Mass. Stress-path methods; Rigid Loaded areas, Rotation of Foundations.

**UNIT IV:**

**Deep Foundations:** Axially loaded single incompressible, compressible floating and end-bearing piles, pile groups; Laterally Loaded Single and Group of Piles.

**UNIT V:**

**Underground Structures:** Stresses and Displacements around Underground Openings unlined and lined tunnels.

**Text Books:**

1. Elastic Solutions for Soil and Rock Mechanics by Poulos, H. G. & Davis, E. H. Wiley, 1973
2. Advanced Soil Mechanics by Das, B. M, CRC Press, Fourth Edition, 2013.

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**(GTE25) ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT**
**(Elective-III / Elective-IV)**

**Course Objectives:**

Student shall be able to

- **introduce** the concepts and consequences of manmade structures on natural environment.
- **create** awareness and to stipulate a methodology for assessing the damage caused.
- **inculcate** the ability to identify, formulates, and solve environment related problems.
- **understanding** the impact of engineering solutions in economic and environmental context.

**Course Outcomes:**

After the completion of the course student should be able to

- **apply** knowledge of environment and ecology to solve problems
- **design** a process for economic and safe aspects for the society.
- **identify**, formulate and solve stability related problems.
- **develop** an understanding of ethical and professional responsibility.

**UNIT I:**

**Basic Concept of EIA:** Initial environmental Examination, Elements of EIA,- factors affecting EIA IMPACT evaluation and analysis, preparation of Environmental Base maps, Classification of environmental parameters.

**UNIT II:**

**E I A Methodologies:** Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, Benefit Analysis.

**UNIT III:**

**Impact of Development Activities and Land Use:** Introduction, Methodology for the assessment of soil and ground water, Delineation of study area, Identification of activities, Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measure.

**UNIT IV:**

**E I A An Surfaced Water, Air and Biological Environment:** Methodology for the assessment of Impacts on surface water environment, Air pollution sources, Generalized approach for assessment of Air pollution Impact, Assessment of Impact on development Activities of Vegetation and wildlife, environmental Impact of Deforestation –Courses and effects of deforestation.

**UNIT V:**

**Environmental Audit & Environmental Legislation:** Objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, on-site activities, evaluation

of Audit data and preparation of Audit report, Post Audit activities, The Environmental pollution Act, The water Act, The Air (Prevention & Control of pollution Act.). EIA Report preparation and Case studies

**Text Books:**

1. Environmental Impact Assessment Methodologies by Anjaneyulu, Y., Taylor & Francis, Second Edition, 2011
2. Environmental Science and Engineering by Glynn, J. and Gary, W. H. K. , Prentice Hall Publishers, 1996

**References:**

1. Environmental Science and Engineering Suresh K. Dhaneja, S.K., Katania & Sons Publication, New Delhi.
2. Environmental Pollution and Control by Bhatia, H. S. Galgotia Publication (P) Ltd, Delhi, 1998

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## (GTE26) GEO-SYNTHETICS AND SOIL-REINFORCEMENT
## (Elective-III / Elective-IV)

**Course Objectives:**

Student shall be able to

- **create** awareness of the latest trends, modern standards and state of the art Techniques for solving geotechnical engineering problems.
- **develop** an ability to design a geosynthetic system to meet desired needs such as economic, environmental and sustainability related**.**
- **indentify** latest trends in the curriculum consisting mostly of practical courses in numerous special aspects of civil engineering
- **apply** the basic knowledge and to solve critical civil engineering problems in the field like landslides, pavements, dams etc.,

**Course Outcomes:**

After the completion of the course student should be able to

- **describe** different concepts and terms used in Civil Engineering.
- **identify** the critical awareness of current issues in Geotechnical Engineering
- **interpret** various techniques, skills, and modern engineering tools for successful carrier in geotechnical engineering practices.
- **solve** various Geotechnical Engineering problems using geosynthetics.

**UNIT I:**

**An Overview of Geosynthetics:** Classification of Geosynthetics, Functions and applications, Properties of geotextiles, geogrids and geomembranes.

**UNIT II:**

**Soil Reinforcement:** Mechanism, Reinforced slopes, Embankments on soft ground, **Reinforced** Embankments and Reinforced soil walls- Internal and External Stability, Slope stabilization.

**UNIT III:**

**Geoenvironmental Applications:** Geomembranes for landfills and ponds, Geosynthetic clay liners, Designing with GCL's, Filtration and Erosion control, Slope protection.

**UNIT IV:**

**Geosynthetics for Highways:** Roadway Reinforcement, Separation, Filtration, Drainage, Reinforcement, Moisture Barrier, Membrane encapsulation.

**UNIT V:**

**Ground Improvement:** Dewatering systems, Prefabricated Vertical drains (PVD), Sand Drains and French Drains.

**Text Books:**

1. Engineering with Geosynthetics by Rao, G. V. & Raju G. V. S. S., Tata McGraw Hill Publishing Company Ltd., 1990
2. Designing with Geosynthetics by Koerner, R. M., Xlibris Corporation, Sixth Edition (Vol. 1) 2012

**References:**

1. Engineering Principles of Ground Modifications by Hausmann, M. R., McGraw-Hill Ryerson Limited, 1990
2. Ground control and Improvement by Xianthakos, Abremson and Bruce., John Wiley & Sons, 1994
3. Ground Improvement by Mosley., CRC Press, Second Edition, 2004
4. Earth Reinforcement and soil structures by Jones, C. J. F. P., Elsevier, 2013

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## (GTE41) OPTIMIZATION TECHNIQUES IN ENGINEERING
## (Open Elective-II)

**Course Objectives:**

Student shall be able to

- Define statement of optimization problem
- Solve optimization problems using linear programming
- Solve optimization problems using Dynamic programming
- Optimize structural elements like beams, trusses and frames and achieve efficient designs based on various applications and objective functions for professional practice.

**Course Outcomes:**

After the completion of the course student should be able to

- Understand Engineering optimization.
- Classify the optimization problems.
- Understand various methods of linear programming & Dynamic programming.

**UNIT I:**

**Introduction to Optimization:** Introduction - Historical developments – Engineering applications of optimization - statement of an optimization problem - classification of optimization problems - Optimization Techniques. Optimization by calculus: introduction - Unconstrained functions of a single variable - problems involving simple constraints _ Unconstrained functions of several variables - treatment of equality constraints _ Extension lo multiple equality constraints - Optimization with inequality constraints - The generalized Newton-Raphson method.

**UNIT II:**

**Linear Programming:** Introduction - Applications of linear programming - standard form of a linear programming problem - Geometry of linear programming problems - Definitions and theorems - Solution of a system of Linear simultaneous equations - pivotal reduction of a general system of equations - Motivation of the simplex Method - simplex Algorithm _ Two phases of the simplex method.

**UNIT III:**

**Non-Linear Programming**: Introduction - Unimoial Function - unrestricted search - Exhaustive search - Dichotomous search - Interval Halving method _ Fibonacci method - Golden section method - comparison of elimination methods _ Unconstrained optimization techniques - Direct search methods - Random search methods _ grid search method - Univariate method - Powell's method - simplex method – Indirect search methods - Gradient of a function - steepest descent method - conjugate gradient - Newton's method.

**UNIT IV:**

**Dynamic Programming:** Introduction - Multistage decision processes - concept of suboptimization and the principle of optimality - computational procedure in dynamic programming - example illustrating the Calculus method of solution - example illustrating the tabular of solution - conversion of a final value problem into an initial value problem - continuous dynamic programming - Additional applications.

**UNIT V:**

**Network Analysis:** introduction - Elementary graph theory - Network variables and problem types - Minimum-cost route - Network capacity problems - Modification of the directional sense of the network.

**Text Books:**

1. Optimization: Theory and Applications by S.S. Rao. John Wiley & Sons, Fourth Edition, 2009
2. Numerical optimization Techniques for Engineering Design with applications by G.N.Vanderplaats. McGraw-Hill College, First Edition, 1984

**Reference:**

1. Introduction to Optimum Design by J.S.Arora, Academic Press, Third Edition, 2011

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## (HIG 41) CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT (Open Elective-II)

**Course Objectives:**

Student shall be able to

- **Understand** role of project management
- **Learn** preparation of project Schedules, Life cycle cost.
- **Learn** about critical construction management
- **Understand** about on BOT, BOOT & PP projects

**Course Outcomes:**

After the completion of the course student should be able to

- **Develop** Organization Structure of Construction Company
- **Estimate** Project Cost and Develop Cost Models
- **Prepare** Contract documents
- Arbitration and settlement of disputes, arbitration and conciliation Act

**UNIT I:**

**Introduction to Project Management:** Construction as industry and its challenges, Role of Project management, systems approach, systems theory and Concepts, Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques, Life cycle of construction projects, time estimates and construction schedules, CPM and PERT, Linear programming, queuing concept, simulation, bidding models, game theory

**UNIT II:**

**Project Cost Estimation:** approximate cost, detailed cost estimates, administrative approval and expenditure sanctions, rate analysis by client and contractor, bidding processes and strategies, Pre-qualification of bidders, construction equipment, equipment economics, various items of construction : Earthwork, Excavation. Earth- moving, Drilling, Blasting, dewatering, foundation, Finishing items, construction safety including of fire and electrical works

**UNIT III:**

**Contract Management:** Why law is critical to construction management, contract, its definition, Indian contract Act, documents forming a contract, Tendering and contractual procedures, stages of awarding contract, general conditions of Indian (domestic) contracts, General conditions of International contracts (FIDIC), contract administration; Duties and responsibilities of parties; important site documents, importance of standards and codes in contract documents.

**UNIT IV:**

**Quality Management and Safety in Construction Industry:** Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan - Compensation

**UNIT V:**

**Interpretation of Contract:** Interpretation of contract in case of inconsistency, post contract problems, contract interpretation, concealed conditions, termination of contract, claims and disputes, dispute resolution techniques, negotiations, arbitration and settlement of disputes, arbitration and conciliation Act, alternate dispute resolutions, delay, liquidated damages, actual damages.

**Text Books:**


1. A Guide to Quantity Surveyors, Engineers Architects and Builders (Vol I: Taking off quantities, Abstracting & Billing; Vol II: Analysis of Prices) by Kharb, K.S.
2. Building and Engineering Contracts by Patil, B.S., Pune


**References:**


1. Law relating to Building and Engineering Contracts in India by Gajerai, G.T., Butterworths.
2. Construction Cost Engineering Handbook by Anghel Patterson - Marcel Dekken Inc
3. Fundamentals of Construction Management and Organisations by K. Waker A Teraih and Jose M. Grevarn
4. A Guide to the Project Management Body of Knowledge (PMBOK), Draft Copy, 1994. A Publication of the Project management Institute, USA.

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## (GTE41) GROUND-FOUNDATION-STRUCTURE INTERACTION
## (Open Elective- II)

**Course Objectives:**

Student shall be able to

- **develop** an understanding to function on multidisciplinary areas.
- **introduce** the concepts and terminology of structure soil interaction.
- **create** ability to identify, formulates, and solve foundation engineering problems.
- **understanding** the impact of engineering solutions in economic and environmental context.

**Course Outcomes:**

After the completion of the course student should be able to

- **identify**, **formulate** and **solve** geotechnical engineering problems.
- **design** a foundation system for economic and safe aspects for the society.
- **improvise** techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.
- **apply** the theoretical knowledge to solve real life problems in the field.

**UNIT I:**

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

**UNIT II:**

**Beam on Elastic Foundation**- Soil Models: Infinite beam, Two-parameters models, Isotropic elastic half space model, Analysis of beams of finite length, combined footings.

**UNIT III:**

**Analysis of Finite Plates**: Axis symmetric loading of circular plate, two-parameter elastic medium, elastic solid medium, Application of strain energy method. Rectangular plates-elastic medium, elastic solid medium. Numerical analysis of finite plates – Finite difference method, Finite element techniques, Discrete element method.

**UNIT IV:**

**Analysis of Axially and Laterally Loaded Piles and Pile Groups**: 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**: Effect of structure on ground foundation interaction, Static and dynamic loads.

**Text Books:**

1. Elastic Analysis of Soil-Foundation Interaction by Selvadurai, A. P. S., Elsevier, 1979
2. Pile Foundation Analysis and Design by Poulos, H. G., and Davis, E. H.,Wiley, 1980

**References:**

1. Foundation Analysis by Scott, R. F., Prentice-Hall, 1981
2. Foundation Design & Analyses by Bowles, J. E., McGraw Hill Education, Fifth Edition
3. Advanced Foundation Engineering by Das, B. M., Cengage learning, Seventh Edition, 2011

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## (GTE52) ADVANCED GEOTECHNICAL ENGINEERING LAB – II

**Course Objectives:**

Student shall be able to

- **know** the concepts of various types of soils.
- **introduc**e traditional program consisting mostly of practical courses related to geotechnical engineering.
- **apply** the knowledge of science, mathematics and engineering with the context of applications in geotechnical engineering
- conduct experiments, **analyze** and **interpret** data related to the various laboratory tests studied in geotechnical engineering.

**Course Outcomes:**

After the completion of the course student should be able to

- **identify** the various types of soils existing at the site.
- **apply** the techniques, skills, and modern engineering tools necessary for engineering practice.
- **predict** probable problems that may be encountered in any project.
- **identify, formulate** and **solve** geotechnical engineering related issues.

**List of Experiments:**

1. Unconfined compressive strength (IS: 2720 (Part 10) – 1985)
2. Vane Shear test (IS: 2720 (Part 30) – 1980)
3. Direct shear test (IS: 2720 (Part 13) – 1986)
4. Triaxial test (IS: 2720 (Part 11) – 1993, IS: 2720 (Part 12) – 1981)
5. Brazilian test (IS: 10082 - 1981)
6. Automated compaction test
7. Stability analysis of geosynthetics reinforced slope using SLOPE/W
8. Contaminant transport modelling using Visual MODFLOW Flex.
9. Electrical conductivity, pH and Total Dissolved Solids for soils. (IS: 14767 – 2000, IS: 2720 (Part-26), 1987
10. Soil strength modification using Geosynthetics

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## (GTE62) MINI PROJECT -II

A mini project work shall be carried out on any topic of Geotechnical Engineering and a seminar should be given on the same along with a brief report.

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**(GTE63) COMPREHENSIVE VIVA-VOCE**

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**(GTE71) INTERNSHIP/DISSERTATION PHASE - I**

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**(GTE72) DISSERTATION PHASE - II**