ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

Geotechnical Engineering

For

M. Tech. Two Year Degree Course

(Applicable for the batches admitted from 2014-15)
(MR-14 Regulations)

Department of Civil Engineering

MALLA REDDY ENGINEERING COLLEGE

(AUTONOMOUS)

(An Autonomous institution, Autonomy granted by UGC and affiliated to JNTUH, Accredited by NAAC with 'A' Grade, Accredited by NBA (2008-11) & Recipient of World Bank Assistance under TEQIP phase – II S.C.1.1for the period (2011-14))
Maisammaguda, Dhulapally (Post. Via. Kompally), Secunderabad – 500 100.
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MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)
Maisammaguda, Dhulapally (Post via. Kompally), Secunderabad – 500100

ACADEMIC REGULATIONS MR 14 FOR M. TECH. (REGULAR) DEGREE COURSE

(Effective for the students admitted into first year from the academic year 2014-2015)

The M.Tech Degree of Malla Reddy Engineering College, Hyderabad shall be conferred on candidates by the Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad who are admitted to the program and fulfill all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to the eligibility, qualifications and Specialization as prescribed by the university/college from time to time.

Admissions shall be made on the basis of merit/rank obtained by the qualifying candidate at an Entrance Test conducted by the University/college or on the basis of any other order of merit approved by the University/college (say **PGECET/GATE)** subject to reservations as laid down by the Government from time to time.

2.0 AWARD OF M. TECH. DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech. Degree, if he pursues a course of study in not less than two and not more than four academic years. However, he is permitted to write the examinations for two more years after four academic years of course work.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four Academic years from the year of his admission, shall forfeit his seat in M. Tech. course.

2.3 The student shall register for all 88 credits and secure all the 88 credits.

2.4 The minimum instruction days in each semester are 90.

3.0 COURSES OF STUDY

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

1. Advanced Manufacturing Systems(AMS) - Shift II
2. Computer Science(CSe) - Shift I
3. Computer Science and Engineering(CSE) - Shift I & II
4. Control Systems(CS) - Shift I & II
5. Digital Systems and Computer Electronics(DSCE) - Shift I
6. Electrical Power Systems (EPS) - Shift I
7. Embedded Systems(ES) - Shift I
8. Geotechnical Engineering(GTE) - Shift I
9. Machine Designs (MD) - Shift I
10. Power Electronics and Electrical Drives(PEED) - Shift II
11. Structural Engineering(SE) - Shift I
12. Transportation Engineering(TE) - Shift II
13. Thermal Engineering(THE) - Shift I
14. VLSI System Design(VLSI SD) - Shift I

3.1 Departments offering M. Tech. Programmes with specializations are noted below:

Branch	Specialization	Specialization Code
Civil Engineering	1. Structural Engineering (SE) 2. Transportation Engineering (TE) 3. Geotechnical Engineering (GE)	11 12 13
Electrical and Electronics Engineering	1. Control Systems (CS) 2. Power Electronics and Electric Drives (PEED) 3. Electrical Power Systems (EPS)	22 23 24
Mechanical Engineering	1. Thermal Engineering (TE) 2. Advanced Manufacturing Systems (AMS) 3. Machine Designs (MD)	31 32 33
Electronics and Communication Engineering	1.Digital Systems and Computer Electronics (DSCE) 2. VLSI System Design (VLSI SD) 3. Embedded Systems (ES)	41 42 43
Computer Science and Engineering	1. Computer Science and Engineering (CSE) 2. Computer Science (CSe)	51 52

4.0 ATTENDANCE

The programs are offered on a unit basis with each subject being considered as a unit.

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

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

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class and their registration shall stand cancelled.

4.5 A prescribed fee shall be payable towards condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

4.7 A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the previous semester including the days of attendance in sports, games, NCC and NSS activities.

5.0 EVALUATION

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

5.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the **average** of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with Part A as 2 questions to be answered out of 4 questions each question for 10 marks and Part B with 4 questions to be answered out of 6 questions each question for 5 marks. If any candidate is absent for any subject of a mid -term examination, an additional exam will be conducted in the deserving cases based on the recommendations of the College Academic Committee. End semester examination is conducted for 60 marks with 5 questions to be answered out of 8 questions, each question carries 12 marks.

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during I year I semester and II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M. Tech. course of study. The Comprehensive Viva-Voce is evaluated for 100 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce.

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

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.5) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher and the second examiner shall be another Laboratory Teacher.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation after taking up a topic approved by the Project Review Committee(PRC).

6.1 A Project Review Committee shall be constituted with Principal as chair person, Head of the Department, Coordinator, Supervisor and two other senior faculty members.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Departmental Academic Committee for its approval. Only after obtaining the approval of the Departmental Academic Committee can the student initiate the Project work. Departmental Academic Committee(DAC) Consists of Head of the Department as Chairman, along with two Senior Professors and few subject experts too.

6.4 If a candidate wishes to change his supervisor or topic of the project he can do so with approval of Departmental Committee. However, the Departmental Committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of topic as the case may be.

6.5 Candidate shall submit status report (in a bound-form) in two stages at least with a gap of 3 months between them.

6.6 The work on the project shall be initiated in the beginning of the second year and the duration of the project is for two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Principal (through Head of the Department) and shall make an oral presentation/demonstration before the PRC.

6.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/ Institute.

6.8 The thesis shall be adjudicated by one examiner selected by the College. For this, Head of the Department shall submit a panel of 3 examiners to the Chief Controller of Examinations of the College, who are eminent in that field with the help of the concerned guide and Head of the department.

6.9 If the report of the examiner is not favorable, the candidate shall revise and resubmit the Thesis, in the time frame as described by PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

6.10 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent
B. Good
C. Satisfactory
D. Not Satisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva- Voce examination.

If the report of the viva-voce is unsatisfactory, the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, he will not be eligible for the award of the degree unless he is asked to revise and resubmit by the Board.

7.0 AWARD OF DEGREE AND CLASS

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

Class Awarded	**% of marks to be secured**
First Class with Distinction	70% and above
First Class	Below 70 but not less than 60%
Second Class	Below 60% but not less than 50%
Pass Class	Below 50% but not less than 40%

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

8.0 WITH-HOLDING OF RESULTS

If the candidate has not paid any dues to the university or if any case of in-discipline is pending against

him, the result of the candidate will be withheld and he will not be allowed into the next higher semester. The issue of the degree is liable to be withheld in such cases.

9.0 TRANSITORY REGULATIONS

9.1 Discontinued, detained or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.
9.2 The candidate who fails in any subject will be given two chances to pass the same subject:otherwise, he has to identify an equivalent subject as per MR14 academic regulations.

10.0 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 College may change or amend the academic regulations and syllabus at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the College.
10.4 Wherever the word he, him or his occur, it will also include she, her and hers.
10.5 Wherever the word 'Subject' occurs in the above regulations, it implies the 'Theory Subject' and 'Practical Subject' or 'Lab'.
10.6 Transfers not allowed among group colleges.

MALPRACTICES RULES
DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any mark son the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shallot be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject tithe academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject

6	Refuses to obey the orders of the Chief Superintendent/Assistant –Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to the person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-incharge,or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police cases registered against them.
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations.
		The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.

12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action toward suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.

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

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)
M.Tech Geotechnical Engineering

COURSE STRUCTURE

I YEAR I SEMESTER

CODE NO	SUBJECT	L	T	P	C
41301	Advanced Soil Mechanics	3	1	0	3
41302	Advanced Foundation Engineering	3	1	0	3
41303	Soil Dynamics and Machine Foundations	3	1	0	3
41304	Engineering of Ground	3	1	0	3
	Elective-I	**3**	**1**	**0**	**3**
40M12	Numerical Methods for Geotechnical Engineers				
413A1	Groundwater Hydrology				
413A2	Geo-Environmental Engineering				
	Elective-II	**3**	**1**	**0**	**3**
413B1	Environment and Ecology				
413B2	Groundwater Contamination and Remediation				
413B3	Finite Element Method for geotechnical engineers				
41305	Advanced Geotechnical Engg. Lab-I	-	-	3	2
41306	Seminar-I	-	3	-	2
	Total	**18**	**9**	**3**	**22**

I YEAR- II SEMESTER

CODE NO	SUBJECT	L	T	P	C
41307	Retaining Structures	3	1	0	3
41308	Earth & Rock Fill Dams and Slope Stability	3	1	0	3
41309	Geosynthetics & Soil Reinforcement	3	1	0	3
41310	Soil-Structure Interaction	3	1	0	3
	Elective-III	3	1	0	3
413C1	Geotechnical Earthquake Engineering				
413C2	Rock Mechanics and Engineering				
413C3	Theoretical Soil Mechanics				
	Elective-IV	3	1	0	3
413D1	Pavement Analysis and Design				
413D2	Environmental Impact Assessment and Management				
413D3	Geographical Information Systems				
41311	Advanced Geotechnical Engg Lab- II	-	-	3	2
41312	Seminar-II	-	3	-	2
	Total	18	9	3	22

II YEAR I & II SEMESTER

CODE NO	TITLE OF THE COURSE	L	T	P	C
41313	Comprehensive Viva	-	3	-	4
41314	Project	-	-	-	40
	Total	-	3	-	44

MALLA REDDY ENGINEERING COLLEGE
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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

ADVANCED SOIL MECHANICS

Course Objectives

1) The main objective of this module is to provide a deeper insight into various aspects of advanced soil behavior which are necessary to consider in contemporary design of geotechnical structures

2) In doing so the module also introduces the concept of a constitutive framework and explains how the observed soil behavior is translated into a mathematical formulation for the use in advanced geotechnical analysis tools.

3) To design and conduct experiments, as well as to analyze and interpret data related to the geotechnical engineering and To create an ability to apply knowledge of geotechnical engineering.

4) To introduce traditional curriculum consisting mostly of practical courses in numerous special aspects of soil engineering.

5) To accentuate the understanding of the basic principles and exposes the student to the latest developments, with a strong research orientation.

UNIT 1

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 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.

Learning Outcomes

On successfully completing this course unit, students will be able to:

1) Develop an understanding of advanced aspect of soil behavior and Make an appropriate Choice of strength parameters to be used in design, based on the nature of the geotechnical Problems

2) Develop an understanding of the critical state framework of soil behaviour and its advantages and limitations.

3) An ability to identify, formulate and solve geotechnical engineering problems.

4) Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.
5) A complete awareness of the latest trends, modern standards and state-of-the-art techniques for geotechnical engineering.
6) An understanding to function on multidisciplinary teams.

References:

1. Atkinson, J.H. and Bransby, P.L. - The Mechanics of Soils: An Introduction to Critical State Soil Mechanics, McGraw Hill.
2. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation, McGraw- Hill Co.
3. Mitchell, J.K. - Soil Behavior.
4. Das, B. M. - Advanced Soil Mechanics, Taylor and Francis.
5. Wood, D.M.- Soil Behavior and Critical State Soil Mechanics.
6. Craig, R. F. - Soil Mechanics, Van Nostrand Reinhold Co. Ltd.
7. Lambe, T. W. and Whitman, R. V. - Soil Mechanics, John Wiley & Sons.
8. Muniram Budhu.- Soil Mechanics and Foundations, John Wiley & Sons, Inc

MALLA REDDY ENGINEERING COLLEGE
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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

ADVANCED FOUNDATION ENGINEERING

Course Objectives

1) The main objective of this subject to plan a site investigation, how to classify and characterize soils for foundation design, how to estimate the capacity of foundations, and how to estimate the settlement of the soil under the foundation load.
2) To create ability to identify, formulates, and solve foundation engineering problems.
3) Develop an understanding of professional and ethical responsibility.
4) Understanding the impact of engineering solutions in economic and environmental context.

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, Pressuremeter; 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 Pressuremeter; 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-α, β and λ 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.

Learning Outcomes

1) Develop an ability to apply knowledge of foundation engineering to solve problems related to geotechnical engineering.

2) An ability to design a foundation system for economic and safe aspects for the society.

3) An ability to identify, formulate and solve foundation related problems**.**

References:

1. Das, B. M. - Principles of Foundation Engineering 5th Edition
2. Bowles, J. E. - Foundation Analysis & Design 5th Edition
3. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design
4. Reese, L. C. & Van Impe, W. F. - Single Piles and Pile Groups under Lateral Loading
5. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Hand Book
6. Tomlinson, M. J. - Foundation Design and Construction
7. Reese, L. C. & Wang, S. T. - Analysis and Design of Shallow and Deep Foundations
8. Salgado, R. - The Engineering of Foundations

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

SOIL DYNAMICS AND MACHINE FOUNDATIONS

Course Objectives

1) To design and conduct experiments, as well as to analyze and interpret data related to the geotechnical engineering
2) To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
4) Understanding the impact of engineering solutions in economic and environmental context.

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 behavior 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.

Learning Outcomes

1) Improvising techniques, skills, and modern engineering tools necessary for successful career in geotechnical engineering practice.
2) An ability to identify, formulate and solve geotechnical engineering problems.
3) A critical awareness of current issues in geotechnical engineering
4) To accentuate the understanding of the basic principles and exposes the student to the latest developments, with a strong research orientation.
5) An ability to identify, formulate and solve foundation related problems.
6) A complete awareness of the latest trends, modern standards and state-of-the-art techniques for geotechnical engineering

References:

1. I.Chowdhary and S P Dasgupta - Dynamics of Structures and Foundation, 2009.
2. Arya, S. D, O'Neil, M. and Pincus, G.- Design of Structures and Foundations for Vibrating Machines, Gulf Publishing Co., 1979.
3. Prakash, S. and Puri, V. K. - Foundation for Machines: Analysis and Design, John Wiley & Sons, 1998.
4. Prakash, S. - Soil Dynamics, McGraw Hill, 1981.
5. Kameswara Rao, N. S. V. - Vibration Analysis and Foundation Dynamics,Wheeler Publication Ltd., 1998.
6. Richart, F. E. Hall J. R and Woods R. D. - Vibrations of Soils and Foundations, Prentice Hall Inc., 1970.
7. Swami Saran - Soil Dynamics and Machine Foundation, Galgotia Publishing, 1999.
8. Das, B. M. - Principles of Soil Dynamics, PWS KENT publishing Company, Boston.
9. Kramer S. L. - Geotechnical Earthquake Engineering, Prentice Hall, 1996.

2014-2015 **Code: 41304**

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(Geotechnical engineering)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

ENGINEERING OF GROUND

Course Objectives

1) Prepare civil engineering students for a career in geotechnical engineering
2) To create ability to identify, formulates, and solve soil stability related problems.
3) Develop an understanding of professional responsibility.
4) Understanding the impact of engineering solutions in economic and environmental context

UNIT I

INTRODUCTION TO ENGINEERING GROUND MODIFICATION: Need and objectives, Identification of soil types, in situ and laboratory tests to characterize problematic soils; Mechanical, Hydraulic, Physico-chemical, Electrical, Thermal methods, etc. and their applications.

UNIT II

MECHANICAL MODIFICATION – Principles of soil densification – Properties of Compacted soil, Compaction control tests, Specification of compaction requirements, Blasting Vibro-compaction, Dynamic Tamping and Compaction piles.

UNIT III

HYDRAULIC MODIFICATION – Objectives and techniques, traditional dewatering methods and their choice, Design of dewatering system, Electro-osmosis, Filtration, Drainage and seepage control with Geo-synthetics, Preloading and vertical drains, Electro-kinetic dewatering.

UNIT IV

PHYSICAL AND CHEMICAL MODIFICATION – Modification by admixtures, Shotcreting and Guniting Technology, Modification at depth by grouting, Crack Grouting and compaction grouting, Jet grouting, Thermal Modification, Ground freezing.

UNIT V

MODIFICATION BY INCLUSIONS AND CONFINEMENT - Soil reinforcement, reinforcement with strip, bar, mesh, sheet and grid reinforced soil. In-situ ground reinforcement, ground anchors, rock bolting and soil nailing.

Learning Outcomes

1 knowledge of important geologic features in the design and construction of underground openings in rock and/or soil.
2. be able to plan and design a subsurface exploration program based on anticipated geologic conditions and potential construction problems.
3) An ability to identify, formulate and solve geotechnical engineering problems.
4) An ability to design a stable soil system for economic and safe aspects for the society.
5) Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in ground engineering.

References:

1. Hausmann, M. R. (1990) – Engineering Principles of Ground Modifications, McGraw Hill publications
2. Koerner, R. M (1994) – Designing with Geosynthetics – Prentice Hall, New Jersey
3. Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.
4. Xianthakos, Abreimson and Bruce - Ground Control and Improvement
5. Mosley – Ground Improvement

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(Geotechnical Engineering)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

NUMERICAL METHODS FOR GEOTECHNICAL ENGINEERS

(ELECTIVE-I)

Course Objectives

1 Students can ability to apply the scientific method to explore problems of relevance to this discipline, is able to use a range of analytical methods, including computer software to analyze relevant data, and field techniques, and can contribute to an advance of knowledge in this discipline.
2) To create an ability to apply knowledge of hydrology.
3) To design and analyze the problems related to the ground water.
4) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

UNIT-I

Approximations and Errors in Numerical Methods; Solutions of Algebraic and Transcendental Equations, Bisection, False Position, Secant & Iterative Methods, Aitken's Δ2, Newton-Raphson, Horner's and Muller's Methods; Comparison of Iterative Methods; Simultaneous Linear Algebraic Equations – methods of solution using inverse of the matrix, method of successive elimination, Iterative methods – Gauss-Siedel method, Relaxation method; Applications.

UNIT-II

Matrix Inversion and Eigenvalue Problems – Power, Jacobi Methods; Calculus of Finite Differences – Differences, Difference Formulae, Difference Table, Factorial Notation; Interpolation – Lagrange's, Newton's, Hermite's, Spline, Inverse Interpolation; Applications.

UNIT-III

Numerical Differentiation – Derivatives, Maxima and Minima of a Tabulated Function; Numerical Integration – Quadrature, Romberg's, Euler-Maclaurin, Double Integration; Applications.

UNIT-IV

Numerical Solution of Ordinary Differential Equations - Modified Euler's, Runge- Kutta's, Predictor-Corrector, Milne's Methods; Partial Differential Equations - Finite Difference Approximations, Elliptic, Laplace, Parabolic, Hyperbolic Equations; Applications.

UNIT-V

Soft Computing -Linear Programming - Simplex Method; Artificial Variable Techniques M Method, Two Phase Method; Applications; ANN, Fuzzy Logic, etc.

References:

1. Grewal, B. S. - Numerical Methods in Engineering & Science.

2. Chapra, S. C. & Canade, R. P. - Numerical Methods for Engineers.

2014-2015 **Code: 413A1**

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(Geotechnical Engineering)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

GROUND WATER HYDROLOGY (ELECTIVE-I)

Course Objectives

1 Students can ability to apply the scientific method to explore problems of relevance to this discipline, is able to use a range of analytical methods, including computer software to analyze relevant data, and field techniques, and can contribute to an advance of knowledge in this discipline.

2) To create an ability to apply knowledge of hydrology.

3) To design and analyze the problems related to the ground water.

4) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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

MODELLING 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.

Learning Outcomes

1) A critical awareness of current issues in hydrology.

2) An ability to identify, formulate and solve problems related to ground water

3) An understanding to function on multidisciplinary teams.

References:

1. David K. Todd - Groundwater Hydrology, John Wiley & Sons. New York.
2. Bear, J. - Hydraulics of Groundwater, McGrawHill, New York.
3. Raghunath, H. M. Groundwater, Wiley Eastern Ltd.
4. Bauer, Groundwater, John Wiley & Sons

2014-2015 **Code: 413A2**

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

GEOENVIRONMENTAL ENGINEERING

(ELECTIVE-I)

Course Objectives

1. To introduce professional issues related to the practice of geotechnical and geoenvironmental engineering.
2 . To understand conceptual, technical and practical aspects of conducting geotechnical and geoenvironmental engineering investigations, for the purpose of developing a "geotechnical model", which forms the basis of subsurface engineering design.
3. To understand the general principles for the remediation of contaminated sites, and develop practical solutions.
4. To appreciate the role and limits of analytical and numerical methods in geotechnical design.

UNIT I

SOURCES AND SITE CHARACTERIZATION: Scope of Geo-environmental Engineering, Various Sources of Contaminations, Need for contaminated site characterization; and Characterisation methods.

UNIT II

SOLID AND HAZARDOUS WASTE MANAGEMENT: Classification of waste, Characterization solid wastes, Environmental Concerns with waste, waste management strategies.

UNIT III

CONTAMINANT TRANSPORT: Transport process, Mass-transfer process, Modeling, Bioremediation, Phytoremediation.

UNIT IV

REMEDIATION TECHNIQUES: Objectives of site remediation, various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies.

UNIT V

LANDFILLS: Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system.

Learning Outcomes

1 Students can learn the main ways pollutants migrate in the sub-surface and the principles of modeling solute transport and The fate and behavior of inorganic and organic pollutants, including their identification and sampling
2) An understanding to function on multidisciplinary teams.
3) A critical awareness of current issues in Geotechnical Engineering.

References:

1. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook
2. Bedient, Refai & Newell - Ground Water Contamination
3. Sharma, H. D. and Reddy, K. R. - Geoenvironmental Engineering
4. Reddi, L. N. and Inyang, H. I. - Geoenvironmental Engineering
5. LaGrega, M. D., Buckingham, P. L. and Evans, J. C. - Hazardous Waste Management

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

ENVIRONMENT AND ECOLOGY
(ELECTIVE-II)

Course Objectives
1) To create ability to identify, formulates, and solve environment related problems.
2) Develop an understanding of professional responsibility.
3) Understanding the impact of engineering solutions in economic and environmental context

UNIT I
ENVIRONMENT, ECOLOGY AND SUSTAINING THE EARTH; Nature and Humans: Earth, population, environment.

UNIT II
ECOSYSTEMS; Ecosystems, ecology of populations, human population dynamics – growth and urbanization; environmental economics and politics.

UNIT III
Hazards, risk and health.

UNIT IV
AIR, WATER AND SOIL RESOURCES: Air Resources, pollution, global warning, ozone depletion; water resources – surface and groundwater, sources of pollution; soil resources – conservation, contamination, salt water intrusion, hazardous wastes.

UNIT V
LIVING RESOURCES FOOD RESOURCES, PESTICIDES, PEST CONTROL: LAND RESOURCES – forests, wetlands, wilderness, national parks; wild plants and animal resources, Energy and Mineral Exploitation: perpetual and renewable energy; non-renewable energy; non-renewable mineral resources, solid and hazardous wastes.

Learning Outcomes

1) Develop an ability to apply knowledge of environment and ecology to solve problems
2) An ability to design a process for economic and safe aspects for the society.
3) An ability to identify, formulate and solve stability related problems

References:

1. Environmental Science by Tyley Miller.
2. Concepts of Ecology by E.J.Kormondy

2014-2015 **Code: 413B2**

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

GROUND WATER CONTAMINATION AND REMEDIATION

(ELECTIVE - II)

Course Objectives

1. Students can learn the main ways pollutants migrate in the sub-surface and the principles of modeling solute transport and the fate and behavior of inorganic and organic pollutants, including their identification and sampling
2. To create an ability to apply knowledge of engineering
3. To design and analyze the problems related to the ground water remediation.
4. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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, in-situ flushing, permeable reactive treatment walls, air sparging, soil vapour extraction, natural attenuation, bioremediation and phytoremediation.

Learning Outcomes

1 Students can learn Sources and types of groundwater contamination, Principles of groundwater movement Calculating groundwater transit times ,Contaminant transport in the subsurface and Case studies of inorganic groundwater pollution ,Introduction to modelling inorganic and organic solute transport

2 An understanding to function on multidisciplinary areas.
3 A critical awareness of current issues in remediation techniques
4 An ability to identify, formulate and solve problems for the environment, society and economic viability.

References:

1 Bedient, Rifai & Newell - Groundwater Contamination (Transport and remediation)
2 Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook
3 Sharma, H. D. and Reddy, K. R. - Geoenvironmental Engineering
4 Reddi, L. N. and Inyang, H. I. - Geoenvironmental Engineering
5 Daniel, D. E. - Geotechnical Practice for Waste Disposal

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	**3**	**1/-/-**	**3**

FINITE ELEMENT METHOD FOR GEOTECHNICAL ENGINEERS

(ELECTIVE-II)

Learning Objectives:
1. 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.
2. To develop the student's skills in applying the interpolation functions to solve bar, beam problems.
3. To provide the student with some knowledge and analysis skills in forming basic data required in a FEM computer program.

UNIT I
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 axi-symmetric 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.
Learning Outcomes:

Students will learn how to apply it to basic (linear) ordinary and partial differential equations.
2. Students will also learn how to implement the finite element method efficiently in order to solve field problems.
3. Identify mathematical model for solution of common engineering problems.

References:
1. Desai, C. and Abel - Introduction to Finite element Method
2. Zienkiewicz, O. C. - Finite element Methods
3. Krishna Murthy, C. S. - Finite element analysis - Theory and programming

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR I SEM	0	**-/3/-**	2

ADVANCED GEOTECHNICAL ENGINEERING LAB – I

Course Objectives

1) To introduce traditional program consisting mostly of practical courses related to geotechnical engineering.
2) To apply the knowledge of science, mathematics and engineering with the context of applications in geotechnical engineering
3) To design and conduct experiments, analyze and interpret data related to the various laboratory tests studied in geotechnical engineering.

List of Experiments

1. Grain size analysis –Sieve and Hydrometer Analysis
2. Consistency Limits-Cone Test for Liquid Limit
3. Proctor Compaction Test
4. Permeability of Clay Soils.
5. Free Swell, Swell Potential, Swell Pressure Test
6. Oedometer Test
7. Triaxial Tests
8. Standard Penetration Test
9. Cone Penetration Test.
10. Electrical Resistivity Test
11. Test for Cation Exchange Capacity
12. WavePropagationTests.

Learning Outcomes

1) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
2) An opportunity to work in groups

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

RETAINING STRUCTURES

Course Objectives
1) To create an ability to apply knowledge of geotechnical engineering.
2) To design and analyze the problems related to the retaining of soils as a part of geotechnical engineering.
3) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

UNIT I
EARTH PRESSURE THEORIES: Rankine's and Coulomb's Earth pressure theories for cohesive and cohesionless soils, 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 STABILISED EARTH: - Failure mechanismsbond 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.

Learning Outcomes
1) A critical awareness of current issues in Geotechnical Engineering.
2) An ability to identify, formulate and solve problemsrelated to retainment of soil.
3) A complete awareness of the latest trends, modern standards and state-of-the-art techniques for geotechnical engineering.

Reference:

1. Das, B. M. - Principles of Foundation Engineering
2. Bowles. J. E. - Foundation Analysis & Design
3. Rowe, R. K. - Foundation Engineering Handbook
4. Winterkorn and Fang - Foundation Engineering Handbook

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)
I YEAR II-SEM

L	T/P/D	C
3	1/-/-	3

EARTH & ROCKFILL DAMS AND SLOPE STABILITY

Course Objectives

1. To create awareness of the latest trends, modern standards and state-of-the-art techniques for solving geotechnical engineering problems.

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 down stream 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: Requirements of compacted rockfill, Shear strength of rockfill, Rockfill mixtures, Rockfill embankments, Earth-core Rockfill dams, Stability, Upstream & Downstream slopes.

References:

1. Sherard – Earth and Earth Rock Dams.
2. Sowers, G. F. and Salley, H. I. – Earth and Rockfill Dams
3. Bharat Singh and Sharma, H. D. – Earth and Rockfill Dams.
4. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons.
5. Bromhead, E. N. (1992). The Stability of Slopes, Blackie academic and professional, London.
6. Christian, Earth & Rockfill Dams – Principles of Design and Construction, Kutzner Published Oxford and IBH. Ortiago, J. A. R. and Sayao, A. S. F. J. - Handbook of Slope Stabilisation, 2004

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)
I YEAR II-SEM

L	T/P/D	C
3	1/-/-	3

GEOSYNTHETICS AND SOIL REINFORCEMENT

Course Objectives

1) To create awareness of the latest trends, modern standards and state-of-the-art techniques for solving geotechnical engineering problems.
2) To develop an ability to design a geosynthetic system to meet desired needs such as economic, environmental and sustainability related.
3) To introduce latest trends in the curriculum consisting mostly of practical courses in numerous special aspects of soil engineering.

UNIT I
AN OVERVIEW OF GEOSYNTHETICS: Description of Geosynthetics, Properties, Functions

UNIT II
SOIL REINFORCEMENT: Mechanism, Reinforced slopes, Embankments on soft ground, Reinforced Embankments, Reinforced soil walls and Slope stabilization.

UNIT III
GEOENVIRONMENTAL APPLICATIONS: Geomembranes for landfills and ponds, Geosynthetic clay liners, designing with GCL's, Filtration, Erosion control, Slope protection.

UNIT IV
GEOSYNTHETICS FOR HIGHWAYS: Roadway Reinforcement, Separation, Filtration, Drainage, Reinforcement, Moisture Barrier, Membrane encapsulation.

UNIT V
GROUND IMPROVEMENT: Drainage, PVDs, French Drains, etc.

Learning Outcomes

1. An understanding to function on multidisciplinary teams.
2. A critical awareness of current issues in Geotechnical Engineering.
3. Improvising techniques, skills, and modern engineering tools necessary for successful
4. career in geotechnical engineering practice.

References:

5. Koerner, R. M. - Designing with Geosynthetics
6. Rao, G. V. & Raju G. V. S. S. - Engineering with Geosynthetics
7. Hausmann, M. R. - Engineering Principles of Ground Modifications
8. Xianthakos, Abremson and Bruce - Ground control and Improvement
9. Mosley - Ground Improvement
10. Jones, C. J. F. P. - Earth Reinforcement and soil structures

MALLA REDDY ENGINEERING COLLEGE
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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

SOIL-STRUCTURE INTERACTION

Course Objectives

1) To develop an understanding to function on multidisciplinary areas.
2) To create ability to identify, formulates, and solve foundation engineering problems.
3) Understanding the impact of engineering solutions in economic and environmental Context

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 halfspace model, Analysis of beams of finite length, combined footings.

UNIT III

PLATES ON ELASTIC CONTINUUM: Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plates.

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, Subgrade 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.

Learning Outcomes

1) An ability to identify, formulate and solve geotechnical engineering problems.
2) An ability to design a foundation system for economic and safe aspects for the society.
3) Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.

References:

1. Selvadurai, A. P. S. - Elastic Analysis of Soil-Foundation Interaction
2. Poulos, H. G., and Davis, E. H. - Pile Foundation Analysis and Design
3. Scott, R. F. - Foundation Analysis
4. Bowles, J. E. - Foundation Design & Analyses
5. Das, B. M. - Advanced Foundation Engineering

MALLA REDDY ENGINEERING COLLEGE
(Autonomous)

M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

GEOTECHNICAL EARTHQUAKE ENGINEERING

(ELECTIVE-III)

Course Objectives

1) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
2) Understanding the impact of engineering solutions in economic and environmental context.
3) To design, analyze and interpret problems and the solution related to the earthquake engineering in geotechnology.

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.

Learning Outcomes

1) To accentuate the understanding of the basic principles and exposes the student to the latest developments, with a strong research orientation.
2) An ability to identify, formulate and solve foundation related problems.
3) A complete awareness of the latest trends, modern standards and state-of-the-art techniques for geotechnical engineering.

References:

1. Kramer S. L - Geotechnical Earthquake Engineering, Prentice Hall, 1996.
2. R. W. Day - Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.
3. Seco e Pinto, Seismic Behaviour of Ground and Geotechnical structure, A. A. Balkema - 1997.
4. Naeim, F. - The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.
5. Bolt, B. A. - Earthquakes, W. H. Freeman and Company, 4th Edition, 1999.
6. Lourie, W. - Fundamentals of Geophysics, Cambridge University press, 1997.

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

ROCK MECHANICS AND ENGINEERING
(ELECTIVE-III)

Course Objectives

1) To create an ability to apply knowledge of Rock mechanics.
2) To design and conduct experiments, as well as to analyze and interpret data related to the rock mechanics.
3) To accentuate the understanding of the basic principles and exposes the student to the latest developments and applications

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.

Learning Outcomes
1) Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in Rock mechanics.
2) A complete awareness of the latest trends, modern standards and state-of-the-art techniques for understanding rock mechanics and engineering.
3) An understanding to function on multidisciplinary teams.

References:
1. Goodman – Introduction to Rock mechanics, Willey International (1980).
2. Ramamurthy, T. - Engineering in Rocks for slopes, foundations and tunnels, Prenice Hall of India.
3. Jaeger, J. C. and Cook, N. G. W. – Fundamentals of Rock Mechanics, Chapman and Hall, London.
4. Hoek, E. and Brown, E. T. - Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982.
5. Brady, B. H. G. and Brown, E. T. - Rock Mechanics for Underground Mining, Chapman & Hall, 1993.

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

THEORETICAL SOIL MECHANICS

(ELECTIVE-III)

Course Objectives

1) To develop an understanding to function on multidisciplinary areas.
2) To create ability to identify, formulates, and solve foundation engineering problems.
3) To introduce traditional concepts consisting mostly of practical courses in numerous special aspects of soil mechanics.

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.

Learning Outcomes

1) An ability to identify, formulate and solve geotechnical engineering problems.
2) Improvising techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.
3) An understanding of professional and ethical responsibility.

References:

1. Poulos, H. G. & Davis, E. H. – "Elastic Solutions for Soil and Rock Mechanics"
2. Das, B. M. – Advanced Soil Mechanics

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

PAVEMENT ANALYSIS AND DESIGN

(ELECTIVE-IV)

Course Objectives
1) To design, analyze and interpret data related to the pavement engineering.
2) An ability to identify, formulates, and solves engineering problems.
3) To develop an ability to apply knowledge of science and engineering in the pavement designs.

UNIT I
INTRODUCTION: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements.

UNIT II
STRESSES AND STRAINS IN FLEXIBLE PAVEMENTS: Stresses and strains in an infinite elastic half space use of Boussinesq's equations - Burmister's two layer and three layer theories; Wheel load stresses, various factors in traffic wheel loads; Equivalent single wheel load of multiple wheels. Repeated loads and EWL factors.

UNIT III
FLEXIBLE PAVEMENT DESIGN METHODS FOR HIGHWAYS AND AIRPORTS: Empirical, semi empirical and theoretical approaches; Development, principle, design steps of the different pavement design methods including AASHTO, Asphalt Institute, Shell Methods. IRC methods of pavement design.

UNIT IV
STRESSES IN RIGID PAVEMENTS: Types of stresses and causes; Introduction to Westergaard's equations for calculation of stresses in rigid pavement due to the influence of traffic and temperature; Considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.

UNIT V
RIGID PAVEMENT DESIGN: Design of cement concrete pavement for highways and runways; Design of joints, reinforcements, tie bars, dowel bars. IRC methods of design; Design of continuously reinforced concrete pavements.

Learning Outcomes
1) An ability to function on multidisciplinary areas
2) An ability to design a system to meet the needs within the realistic constraints such as environment, safety, sustainability and economic viability.
3) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

REFERENCES:

1. Design of Functional Pavements, Nai C. Yang, McGraw Hill Publications
2. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers
3. Principles of Pavement Design, Yoder.J. & Witzorac Mathew, W. John Wiley & Sons Inc
4. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.
5. Pavement and Surfacings for Highway & Airports, Micheal Sargious, Applied Science Publishers Limited.
6. IRC Codes for Flexible and Rigid Pavements design

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

(ELECTIVE-IV)

Course Objectives
1) To create ability to identify, formulates, and solve environment related problems.
2) Develop an understanding of ethical and professional responsibility.
3) Understanding the impact of engineering solutions in economic and environmental context.

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 ON 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

Learning Outcomes
1) Develop an ability to apply knowledge of environment and ecology to solve problems
2) An ability to design a process for economic and safe aspects for the society.
3) An ability to identify, formulate and solve stability related problems

REFERENCES:

1. Anjaneyulu, Y. - Environmental Impact Assessment Methodologies, B. S. Publication, Sultan Bazar, Hyderabad
2. Glynn, J. and Gary, W. H. K. - Environmental Science and Engineering, Prentice Hall Publishers
3. Suresh K. Dhaneja - Environmental Science and Engineering, S.K.,Katania & Sons Publication., New Delhi.
4. Bhatia, H. S. - Environmental Pollution and Control, Galgotia Publication(P) Ltd, Delhi.

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	**3**	**1/-/-**	**3**

GEOGRAPHICAL INFORMATION SYSTEMS

(ELECTIVE-IV)

Course Objectives

1) To introduce traditional curriculum consisting mostly of practical courses in numerous special aspects of soil engineering.
2) To accentuate the understanding of the basic principles and exposes the student to the latest developments, with a strong research orientation.
3) To mould the students with broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

UNIT I

INTRODUCTION: Electromagnetic spectrum, energy sources and Radiation principle, Energy interactions in the atmosphere, energy interactions with earth surface features – Vegetation, Soil and water.

UNIT II

DATA ACQUISITION: Platforms – sensors used for the remote sensing data acquisition. Data processing – Radiometric, Geometric corrections.

UNIT III

DIGITAL IMAGE PROCESSING: Image enhancement – linear, non-linear spatial filtering; edge enhancement. Classification – supervised, unsupervised classification.

UNIT IV

GEOGRAPHICAL INFORMATION SYSTEM (GIS): Definition data input and output; Topology, Digital elevation data; Data management – relational data model. Spatial data models – Raster and Vector data Models. GIS analysis – Classification, overlay operation.

UNIT V

LAND USE/LAND COVER ANALYSIS: Classification principles and systems; Applications of soil, water resources, environmental, earthquakes, landslides. Software scenario – watershed modeling, watershed management, environmental modeling.

Learning Outcomes

1) An understanding to function on multidisciplinary teams.
2) A critical awareness of current issues in Geotechnical Engineering.
3) Improvising techniques, skills, and modern engineering tools necessary for successful career in geotechnical engineering practice

References:

1. F.F. Sabin's Jr., - Remote Sensing Principles and Interpretations – W.H. Freeman & Co.
2. Lilles and Kiefer – Remote Sensing Principles and Interpretation – John Willey and Sons. America, 2000.
3. Paul J. Gibson & Clare H. Power – Introductory Remote Sensing – British Library, London. 1st Published, 2000.
4. Stan Arnoff – Geographic Information Systems – A management perspective, Canada, 1995.

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M.TECH.(GEOTECHNICAL ENGINEERING)	**L**	**T/P/D**	**C**
I YEAR II-SEM	0	**-/3/-**	2

ADVANCED GEOTECHNICAL ENGINEERING LAB – II

Course Objectives

1. To introduce traditional program consisting mostly of practical courses related to geotechnical engineering.
2. To apply the knowledge of science, mathematics and engineering with the context of applications in geotechnical engineering
3. To design and conduct experiments, analyze and interpret data related to the various laboratory tests studied in geotechnical engineering.

List Of Experiments

1. Preparation of Rock Specimen (Drilling, Cutting, Polishing)
2. Slake Durability Test
3. Brazilian Test
4. Point Load Test
5. Unconfined Compression Test
6. Interface Shear Behavior of Soils with Geosynthetics
7. Cone Drop Test on Geotextile
8. Tensile Tests (Wide Width, Narrow Width, etc. on Geotextiles)
9. CBR Push Through on Geotextiles
10. In-Plane and Cross-Plane Permeability of Geotextiles

Learning Outcomes

1. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
2. An opportunity to work in groups
3. An ability to identify, formulate and solve geotechnical engineering related issues