ACADEMIC REGULATIONS (R18PG)

COURSE STRUCTURE AND DETAILED SYLLABUS

For

M.Tech.- Regular Two Year Post Graduate Degree Programe

(Effective from 2018-19)

MASTER OF TECHNOLOGY
IN
GEOTECHNICAL ENGINEERING

KANDULA SRINIVASA REDDY MEMORIAL COLLEGE OF ENGINEERING

(UGC-Autonomous)

Kadapa 516003, A.P

(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)

(An ISO 14001:2004 & 9001: 2015 Certified Institution)

E-mail: principal@ksrmce.ac.in **Website:** www.ksrmce.ac.in

ABOUT THE COLLEGE

The college owes its existence to the keen interest of Late Kandula Obul Reddy to develop technical education in Rayalaseema region of Andhra Pradesh. With a view to translating his noble ideal of imparting technical education into reality, a Technical Training Institute at Vempalli, Kadapa District was started in 1979 under the aegis of Sri Kandula Obul Reddy charities. It is in the year 1980 that K.S.R.M. College of Engineering was established to perpetuate the memory of Late Sri. Srinivasa Reddy, youngest son of Late Sri Obul Reddy. Sri Srinivasa Reddy, a brilliantstudent of III year Mechanical Engineering at Delhi College of Engineering, New Delhi, met with his untimely death in a scooter accident on 18th Oct, 1979. The college was formally inaugurated on 14 November 1980 by Sri T. Anjaiah, the Chief Minister of Andhra Pradesh and it started functioning from the academic year 1980-81.

The college had its modest beginnings in 1980 with an intake of 160 students with core branches "Civil, Electrical & Electronics, Electronics & Communications and Mechanical Engineering. Keeping in view the latest trends, priorities and relevance in Engineering and Technology, the Board of Management decided to start Computer Science and Engineering in 1990 commemorating the decennial year of the college. With the conserted efforts of the Management and the Successive Principals, the departments have been strengthened year after year and the intake has steadily been increased to 1080 by the year 2014. Furthering its sphere of activity, the college started post graduate programme in CAD/CAM (ME), Geo-technical Engineering (CE) in the year 2004, Power Systems (EEE) & Computer Science and Engineering (CSE) during 2010-11 and Digital Electronics and Communication Systems (ECE) in 2011-12 respectively. The branches have constantly been strengthened by increasing the intake from time to time. This reflects one aspect of the progress and development of the college.

The College campus is located 7 K.M. away from Kadapa town on Kadapa to Pulivendula Highway in a calm and salubrious area of 35 acres. The College is set in a serene environment with lush greenery and fresh air. Four multi-storeyed RCC structures measuring 26,700 sqm provide accommodation for the departments. The College has dedicated electric power feeder and 250 KVA substation. Other capital resources include transport vehicles and four hostels. Excellent Bus facilities exist from Kadapa to Hyderabad, Vijayawada, Nellore, Tirupati, Kurnool, Bangalore, Chittoor and Chennai.

VISION

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

MISSION

M1: To provide high quality education with enriched curriculum blended with impactful teaching learning practices.

M2: To promote research, entrepreneurship and innovation through industry collaborations.

M3: To produce highly competent professional leaders for contributing to Socio-economic development of region and the nation.

ABOUT THE DEPARTMENT

Civil Engineering Department of KSRM College of Engineering is one of the five founding departments since the college was established in the year 1979. The motto of the department is EXCEED (Excellence in Civil Engineering Education). The department is offering B.Tech program with an intake of 180 students. The department is also offering M.Tech program in Geotechnical Engineering with an intake of 18 students. The department has well equipped laboratories needed for undergraduate and post graduate students. The department produced many skilled engineers, the bulk of whom made successful lives for themselves in India and abroad since inception. The department provides valuable consultancy services to various Government and Non-governmental Departments and individual firms in and around Rayalaseema region. The Civil Engineering Department is recognized as research center by JNTUA, Ananthapuramu. AICTE sponsored 13.55 Lakhs under MODROBS scheme to modernize and equip with latest digital equipment in Geotechnical Engineering Lab. The department undertakes all the infrastructure development and maintenance activities/works across the Kandula Group of Institutions-Kadapa.

VISION

To become a frontrunner in the field of Civil Engineering, and tackle national and global challenges that aligns with the needs of society.

MISSION

M1: To provide value added education and cope up with the changes through innovative and dynamic curriculum.

M2: To engage in research that creates state-of-the-art technologies and futuristic knowledge, with a strong emphasis on meeting the socio-economic requirements of society.

M3: To produce globally competent professionals with leadership skills, team work and ethical conduct.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1 - To excel in professional career in the industry or to be a successful entrepreneur to create a sustainable built environment.

PEO2 - To pursue higher education and involve in research with zeal for lifelong learning.

PEO3 - To demonstrate leadership qualities, ethical values and environmental awareness, to serve the society.

PROGRAMME OUTCOMES

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

The graduates in Civil Engineering will be able to

PSO 1: Analyze, Design, Construct, Maintain and Operate infrastructural projects.
PSO 2: Assess the environmental impact of various projects and take required measures to curb environmental deterioration.
PSO 3: Use latest software pertaining to various streams of Civil Engineering.

KSRM College of Engineering, Kadapa-516003, AP

Regulations, Curriculum and Syllabus for M. Tech

KSRM College of Engineering, Kadapa-516003, AP

Regulations for PG Programs in Engineering (R18PG)

1.0 Nomenclature

1.1 *Academic Term*: Extent of time during which academic instructions are initiated and completed

1.2 *Academic Year*: Academic Term of, approximately, one year duration that usually starts in June/July and ends in April/May next

1.3 *Semester*: Either of two Academic Terms that make up an Academic Year

1.4 *Major*: A specific field of study

1.5 *Minor*: An area outside of, or complementary to, a Major

1.6 *Subject*: An area of knowledge that is studied as part of a Course

1.7 *Core*: A subject that is mandatory for a Major course of study

1.8 *Elective*: A subject that is selected for study to suit one's individual needs

1.9 *Audit Subject*: A subject that is studied to meet certain requirements but has no credits assigned to it

1.10 *Humanities*: Subjects that describe and interpret human achievements, problems and historical changes at individual and societal levels covering the disciplines of literature, history, and philosophy

1.11 *Social Sciences*: Subjects that describe the mental and behavioural activities of individuals, groups, organizations, institutions, and nations covering the disciplines of anthropology, economics, linguistics, political science, and psychology

1.12 *Exam*: A test to measure one's progress, knowledge, or ability in a subject

1.13 *Credit*: A numerical weight given to a subject

1.14 *Grade*: A numerical or alphabetic designation measuring the level of achievement in an exam

1.15 *Attendance*: Physical presence of oneself in a classroom/laboratory for purpose of a scheduled academic instruction

1.16 *Course*: A series of subjects that constitute a Major field of study

1.17 *Branch*: Same as Course

1.18 *Program*: Same as Course

1.19 *Specialization*: Same as branch

1.20 *Degree*: An academic title conferred to honour distinguished achievement

2.0 Short Title and Application

2.1 These rules and regulations may be called as R18PG and come into force from Academic Year 2018-19 and exist until superseded by new regulations

2.2 These rules and regulations are applicable to all post graduate courses in engineering and technology leading to Master's Degree in Technology (M. Tech)

2.3 The Specializations offered, at present, are:

2.3.1 Geotechnical Engineering

2.3.2 Power Systems

2.3.3 CAD & CAM

2.3.4 Digital Electronics and Communication Systems

2.3.5 Computer Science and Engineering

2.4 The Institute may offer new Specializations in future to which these rules and regulations will be applicable

3.0 Suspension and Amendment of Rules

3.1 Academic Council has the authority to suspend a rule temporarily

3.2 Academic Council has the authority to amend a rule

3.3 For affirmative action on any suspension or amendment of a rule, an affirmative vote of three-fifths of the members present and voting shall be required in Academic Council

4.0 Requirements for Admission

4.1 At present, admissions into first semester of various Specializations are governed by Government and the Affiliating University. The eligibility criteria and procedure for admission are prescribed by Government and Affiliating University

4.2 A student is not allowed change of Specialization after admission

4.3 A student must fulfil medical standards required for admission

4.4 The selected students are admitted into first semester after payment of the prescribed fees

5.0 Structure of the M. Tech course

5.1 *Duration*: The duration of M. Tech degree course is four semesters

5.2 *Working Days*: Calendar for any semester shall be announced at least four weeks before its commencement. Minimum number of working days is 90 per semester

5.3 *Curriculum*: Each Specialization shall have core, elective and audit subjects. The curriculum for each Specialization shall be approved by its corresponding Board of Studies and then by the Academic Council

5.4 *Credits*: All subjects that are assessed for marks have credits assigned to them. The credits assigned to subjects shall be given in curriculum. The total number of credits for entire course is 68 for all Specializations. The distribution of total credits semester-wise is given in Table 1

Table 1 Semester-wise Total Credits

Semester	Total Credits
First Semester	18
Second Semester	18
Third Semester	16
Fourth Semester	16
Total for entire course	**68**

5.5 The curriculum and syllabus is given in Annexure-1 and Annexure-2 respectively

5.6 Responsibility and Advising: It is the responsibility of the student to understand and know the regulations and requirements to earn the degree. Each student admitted in to the degree programs is assigned to a Faculty Advisor who assists the student in designing an effective program of study. Students should consult their Faculty Advisors for selection of electives and for general advice on academic program

6.0 Registration and Enrolment

6.1 Prior to opening of each semester, every student shall register for all the credit-bearing and audit subjects listed in curriculum of the term. Excepting first semester, the registration for a semester shall be done during a specified week after end examinations of previous semester. In first semester, the registration shall be done within six working days from date of opening. Recommendation of Faculty Advisor is needed for registration

6.2 Late registration will be permitted with a fine, decided from time to time, up to six working days from the last date specified for registration

6.3 A student will be eligible for registration for a semester if she or he i) is promoted to that semester, ii) has cleared all fees to the Institute, library and hostel of previous term, and iii) is not disqualified for registration by a disciplinary action of the Institute

6.4 A student will be enrolled and allowed to attend the classes on successful registration and payment of necessary fees to Institution, library, and hostel

6.5 Registration and enrolment will be controlled by the Office of the Controller of Examinations

7.0 Assessment Procedure – Internal Tests and End Examinations

7.1 Performance of students in all subjects is assessed continuously through internal assessment tests and an End examination

7.2 Allocation of internal assessment and End examination marks

7.2.1 For theory subjects, the allocation is 40 marks for internal assessment and 60 marks for End examination totalling 100 marks

7.2.2 For laboratory/project work subjects, the allocation is 50 marks for internal assessment and 50 marks for End examination totalling 100 marks

7.2.3 For mini-project/mini-project with seminar total 100 marks are allocated for internal assessment. There shall be no end examination for this mini-project

7.2.4 For all audit subjects the allocation is 40 marks for internal assessment and no allocation for End examination

7.3 Internal Assessment Examinations

7.3.1 Internal assessment means performance evaluation of students by faculty members who teach the subjects

7.3.2 For theory subjects, including audit subjects, the internal assessment shall be done by midterm tests. For each subject, two midterm tests will be conducted for 40 marks each and the internal assessment mark is the better of two marks. If any student abstains for any midterm test, she or he will be awarded zero marks for that midterm test.

7.3.3 For laboratory/practical subjects, the internal assessment will be based on regular laboratory work over full term. The assessment will be done by the faculty concerned. The students shall be informed sufficiently early of the procedure to be followed for internal assessment

7.3.4 For subjects like seminar, project-work, industrial training, and comprehensive viva-voce, the internal assessment will be done by a concerned Department Committee consisting of two senior faculty members and faculty guide of concerned student. The assessment procedure will be informed sufficiently early to the students

7.4 End examinations

7.4.1 End examinations shall be conducted after completion of coursework in each term

7.4.2 The question papers for theory subjects shall be set by faculty members outside of the Institute. The external faculty members for question paper setting will be selected by the Principal

7.4.3 Evaluation of answer scripts shall be done by faculty members from outside of the Institute selected by the Principal

7.4.4 For laboratory subjects, end examination shall be conducted by a committee consisting of two internal examiners. One examiner shall be recommended by Head of Department of concerned Major, and the other examiner shall be appointed by the Principal

7.4.5 For project work viva-voce, End examination shall be conducted by a committee consisting of one internal examiner, one external examiner, and the concerned guide of the student. Internal examiner shall be appointed by Head of Department of concerned Major, and the external examiner shall be appointed by the Principal

7.4.6 If a student abstains from End examination of any subject, for any reason, she or he shall be awarded zero marks in that subject

7.4.7 There is no end examination for audit subjects.

8.0 Method of Assigning Letter Grades and Grade Points

8.1 For all credit-bearing subjects, performance of a student in a subject is indicated by a letter grade that corresponds to absolute marks earned in that subject. Each letter grade is assigned a numeric Grade Point that is used to compute Grade Point Average on a scale of 0 to 10

8.2 Performance of a student in both internal assessment and End examination will be considered for awarding grades for credit bearing subjects. Total marks earned in a subject is the sum of marks obtained in internal and End examinations in that subject

8.3 Pass grade A+ to D- is assigned to a subject based on total marks earned in that subject provided that a student earns at least i) 35% of marks in End examination marks and ii) 40% of marks in internal and End examination marks put together; otherwise fail grade F will be assigned to that subject

8.4 Grade I will be assigned to a subject if a disciplinary action is pending and is not resolved before publication of results. Office of Controller of Examinations shall resolve the pending disciplinary action within six working days from the date of publication of results and change the grade to any of A+ to D- or F

8.5 Grade X will be assigned to a subject if a student abstains for End examination of that subject

8.6 The absolute marks and corresponding letter grade and grade points are given in Table2

Table 2 Letter Grades and Grade Points

Absolute Marks	Letter Grade	Grade Points	Remark
95-100	A+	10.0	Pass
90-94	A	9.5	Pass
85-89	A-	9.0	Pass
80-84	B+	8.5	Pass
75-79	B	8.0	Pass
70-74	B-	7.5	Pass
65-69	C+	7.0	Pass
60-64	C	6.5	Pass
55-59	C-	6.0	Pass
50-54	D+	5.5	Pass
0-49	F	0.0	Fail
-	I	0.0	Result Withheld
-	X	0.0	Absent for End Exam

8.7 *SGPA*: Semester Grade Point Average indicates the performance of a student in all credit-bearing subjects of a term. SGPA is calculated as the weighted average

of Grade Points of all subjects of the term with corresponding credits of subjects as weights. Audit subjects are not considered for SGPA calculation

8.8 *CGPA*: Cumulative Grade Point Average indicates the performance of a student in all terms up to and including the current term under consideration. CGPA is calculated as the weighted average of SGPAs with total credits in each term as the weights

8.9 *Grade Card*: All students shall be issued Grade Cards after the publication of results of a term. Grade Card is a statement of performance of a student in a term. It contains information about each registered subject: type of subject, allocated credits, and letter grade earned. SGPA and CGPA will also be indicated

9.0 Requirements for Completing Subjects

9.1 A student shall complete all credit-bearing and audit subjects successfully to be eligible for award of degree

9.2 *Credit-bearing subjects*: A student is considered to have completed a credit-bearing subject successfully and earned credits if she or he obtains a pass grade from A+ to D- in that subject. If a student receives fail grade F or X in any subject, she or he must register for supplementary End examination for that subject as and when opportunity arises and improve grade to pass grade

9.3 *Audit subjects*: A student is considered to have successfully completed an audit subject if she or he earns at least 40% of marks in internal assessment marks. A student may request for makeup tests to satisfy this requirement by paying requisite fee

10.0 Requirements for taking End Examinations

10.1 A student is eligible to take regular End Examinations of current semester if she or he full fills the attendance requirement

10.2 A student shall be promoted from current term to succeeding term on satisfying the attendance requirement

10.3 A student shall complete all credit-bearing and audit subjects successfully before taking End examination for project viva-voce

10.4 Attendance Requirement

10.4.1 Attendance of students shall be recorded for credit-bearing and audit subjects as per the workload indicated in curriculum

10.4.2 Total class-periods conducted shall be reckoned from beginning to end of a term as published in academic calendar

10.4.3 Aggregate Percentage of Attendance is calculated using total number of class-periods attended as numerator and total number of class-periods conducted for the concerned subject as the denominator

10.4.4 A minimum aggregate attendance of 75% is required for promotion to succeeding term

10.4.5 A student can appeal to Academic Council for condoning deficiency in aggregate attendance if she or he gets 65% or more aggregate attendance presenting a valid reason for deficiency. Such a student will be granted

promotion if Academic Council pardons the deficiency. Academic Council has the right to reject the appeal if it is not satisfied with the performance of the student or the reason cited for deficiency of the attendance

10.4.6 A student earning less than 65% aggregate attendance will be denied promotion. A student who is not promoted on basis of attendance shall be removed from the rolls and shall register for the same term when opportunity arises. The current term record of the student is cancelled automatically

10.5 A student can forego promotion and opt to repeat the current term on written request. Recommendation of the concerned Faculty Advisor is required for cancellation of promotion. This option shall be exercised before the commencement of the End examinations of the current term

11.0 Revaluation of End Examination Scripts

11.1 Revaluation of End Examination scripts is allowed for theory subjects only by paying requisite fee

11.2 A Procedure for Revaluation: The script will be revaluated by an examiner appointed by the Principal. The maximum of revaluation and regular end examination marks will be awarded for that subject

11.3 A student can apply for revaluation in a subject only once

12.0 Supplementary End Examinations

12.1 Students are eligible to take Supplementary examinations in subjects with fail grade F or X only

12.2 Supplementary examinations for even semester subjects will be conducted with regular examinations of odd semester subjects and vice versa

12.3 A student will be allowed to improve grade in any theory subject provided she or he has completed coursework of all terms but before award of provisional/final degree

13.0 Requirements for Award of M. Tech degree

13.1 Time Limit for completion of requirements for award of degree is four calendar years from the date of admission. A student who could not complete all the requirements in this time limit shall forego admission and will be removed from the rolls of the Institute

13.2 A student shall be eligible for award of degree provided she or he has:

13.2.1 Registered and successfully completed all required credit-bearing and audit subjects with a total of 68 credits

13.2.2 Secured a CGPA of 4.5 or more

13.2.3 Cleared all dues to the Institute, library and hostel

13.2.4 No disciplinary action is pending against her or him

13.2.5 Satisfied any other stipulation of the affiliating University

13.3 Award of Class: Each student will be given class in degree based on CGPA as given in Table 3

Table 3 Class of Degree

Class of Degree	Range of CGPA
Second Class	>= 5.5 but <6.5
First Class	>= 6.5 but <7.5
First Class with Distinction	>= 7.5

13.4 Consolidated Grade Card and Degree will issued under the seal of affiliating University.

14.0 Transitory Regulations

14.1 A student who initially joins the Institute in a previous Regulation and has to rejoin in an academic-term of the present Regulations, due to any reason, shall be bound by the rules of the current Regulations. Board of Studies of the concerned Major will specify, extra or otherwise, academic coursework to be undertaken by such students who rejoin the current Regulations

COURSE STRUCTURE

M.Tech. (Geo-Technical Engineering)-R18PG Course Structure

Annexure-1 Curriculum

First Semester

S. No.	Core code	Core/ Elective	Course Name	L	T	P	IM	EM	CR
1	1851101	Core 1	Advanced Soil Mechanics	3	0	0	40	60	3
2	1851102	Core 2	Advanced Foundation Engineering	3	0	0	40	60	3
3	1851103 1851104 1851105	PE 1	1. Soil Structure Interaction 2. Ground Improvement Techniques 3. Pavement Analysis and Design	3	0	0	40	60	3
4	1851106 1851107 1851108	PE 2	1. FEM in Geo-Mechanics 2. Environmental Geo-Technology 3. Critical Soil Mechanics	3	0	0	40	60	3
5	1851109	MLC	Research Methodology & IPR	2	0	0	40	60	2
6	Audit Course		Audit Course-I	2	0	0	40	0	0
7	1851110	Lab 1	Soil Mechanics – 1 Laboratory	0	0	4	50	50	2
8	1851111	Lab 2	Soil Mechanics – 2 Laboratory	0	0	4	50	50	2
			Total	**16**	**0**	**8**	**340**	**400**	**18**

Second Semester

S. No	Core code	Core/ Elective	Course Name	L	T	P	IM	EM	CR
1	1851201	Core 3	Dynamics of Soil and Foundations	3	0	0	40	60	3
2	1851202	Core 4	Subsurface Investigations and Instrumentation	3	0	0	40	60	3
3	1851203 1851204 1851205	PE 3	1. Offshore Geo-Technical Engineering 2. Computational Geo-Mechanics 3. Engineering Rock Mechanics	3	0	0	40	60	3
4	1851206 1851207 1851208	PE 4	1. Earth Retaining Structures 2. Design of Underground Excavations 3. Physical and Constitutive Modeling on Geo-Mechanics	3	0	0	40	60	3
5	1851209	Project	Mini-Project	0	0	4	100	00	2
6	Audit Course		Audit Course-II	2	0	0	40	00	0
7	1851210	Lab 3	Sub Soil Exploration Laboratory	0	0	4	50	50	2
8	1851211	Lab 4	Geo-Technical Engineering Modeling Laboratory	0	0	4	50	50	2
			Total	**14**	**0**	**12**	**400**	**340**	**18**

Third Semester

S. No.	Core code	Core/ Elective	Course Name	L	T	P	IM	EM	CR
1	1851301 1851302 1851303	PE 5	1. Stability Analysis of Slopes 2. Foundation on Weak Rocks 3. Geo-Technical Earthquake Engineering	3	0	0	40	60	3
2	OE		Open Elective Courses	3	0	0	40	60	3
3	1851310	Major Project	Dissertation Stage – 1 (to be continued next semester)	0	0	20	100	00	10
			Total	**6**	**0**	**20**	**180**	**120**	**16**

Fourth Semester

S. No.	Core code	Core/ Elective	Course Name	L	T	P	IM	EM	CR
1	1851401	Major Project	Dissertation Final Stage (continued from 3rd semester)	0	0	32	50	50	16
			Total	**0**	**0**	**32**	**50**	**50**	**16**

List of Audit Courses offered:

Course Codes	Course Name
1870A01	English for Research Paper Writing
1870A02	Disaster Management
1870A03	Sanskrit for Technical Knowledge
1870A04	Value Education
1870A05	Constitution of India
1870A06	Pedagogy Studies
1870A07	Stress Management by Yoga
1870A08	Personality Development through Life Enlightenment Skills

List of Open Elective Courses offered:

Course Codes	Course Name
1871304	Business Analytics
1871305	Industrial Safety
1871306	Operations Research
1871307	Cost Management of Engineering Projects
1871308	Composite Materials
1871309	Waste to Energy

M.TECH.-I- SEMESTER SYLLABUS

Course Title	ADVANCED SOIL MECHANICS				M.Tech GTE I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851101	CORE-1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To explain about the consolidation theory
- To explain about the strength behaviour of soil under various conditions
- To analyse the stress paths for different practical situations
- To study the critical parameters in soils
- To study the elastic and plastic deformations in soils

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students obtain the complete knowledge on strength of soil mass
CO 2	The students are able to develop mathematical models for solving different problems in soil mechanics

UNIT – I

Compressibility of Soils: Consolidation Theory (One, Two, and Three Dimensional Consolidation Theories), Consolidation in Layered Soil and Consolidation for Time Dependent Loading, Determination of Coefficient of Consolidation (Casagrande Method and Taylors Method)

UNIT – II

Strength Behavior of Soils; Mohr Circle of Stress; UU, CU, CD Tests, Drained and Undrained Behavior of Sand and Clay, Significance of Pore Pressure Parameters; Determination of Shear Strength of Soil; Interpretation of Triaxial Test Results.

UNIT – III

Stress Path; Drained and Undrained Stress Path; Stress Path With Respect to Different Initial State of the Soil; Stress Path for Different Practical Situations.

UNIT – IV

Critical State Soil Mechanics; Critical State Parameters; Critical State for Normally Consolidated and Over Consolidated Soil; Significance of Roscoe and Hvorslev State Boundary Surface; Drained and Undrained Plane. Critical Void Ratio; Effect of Dilation in Sands; Different Dilation Models.

UNIT – V

Elastic And Plastic Deformations: Elastic Wall; Introduction to Yielding and Hardening; Yield Curve and Yield Surface, Associated and Non-Associated Flow Rule.

Text Books:

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to Critical soil mechanics, McGraw Hill, 1978.
2. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997.
3. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.

Reference Books:

1. Craig, R.F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
2. Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
3. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley & Sons, 1979.

Course Title	ADVANCED FOUNDATION ENGINEERING				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851102	CORE-2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To emphasize the importance of soil investigations including destructive and non-destructive methods
- To explain the concept of bearing capacity and how to estimate the safe bearing capacity for various foundation system including settlement consideration
- To explain the need and how do analysis the pile and pile group under various soil conditions and the concepts of Terzaghi and IRC Methods and individual components
- To explain the concepts of collapsible and expansive soils and design of foundations
- To analyse the foundations under uplifting loads

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students will be able to decide the type of foundations to be recommended for construction of different engineering structures
CO 2	The students will be able to design different types of foundations

UNIT – I

Planning of Soil Exploration for Different Projects, Methods of Subsurface Exploration, Methods of Borings Along with Various Penetration Tests

UNIT – II

Shallow Foundations, Requirements for Satisfactory Performance of Foundations, Methods of Estimating Bearing Capacity, Settlements of Footings and Rafts, Proportioning of Foundations Using Field Test Data, IS Codes.

UNIT – III

Pile Foundations, Methods of Estimating Load Transfer of Piles, Settlements of Pile Foundations, Pile Group Capacity and Settlement, Negative Skin Friction of Piles, Laterally Loaded Piles, Pile Load Tests, Analytical Estimation of Load- Settlement Behavior of Piles, Proportioning of Pile Foundations, Lateral and Uplift Capacity of Piles.

Well Foundation, IS and IRC Codal Provisions, Elastic Theory and Ultimate Resistance Methods

UNIT – IV

Foundations on Problematic Soils: Foundations for Collapsible and Expansive Soil

UNIT – V

Coffer Dams, Various Types, Analysis and Design Foundations under Uplifting Loads.

Text Books:

1. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.
2. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press, 1999.

Reference Books:

1. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 1994.
2. Poulos, H. G. and Davis, F. H., "Pile Foundation Analysis and Design", Wiley and Sons. 1980

Course Title	SOIL STRUCTURE INTERACTION				M.Tech GTE I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851103	PE-1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To study the soil and foundation behaviour
- To analyse the beams on elastic foundations
- To analyse the plates on elastic medium
- To analyse the piles on elastic medium
- To analyse the load prediction on piles

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can apply different soil response models for specific problem based on the requirement.
CO 2	Students can analyze footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.
CO 3	Student can compute pile response for various loading condition for design purpose.

UNIT – I

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

UNIT – II

Beam on Elastic Foundation - Soil Models: Infinite beam, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

UNIT – III

Plate on Elastic Medium: Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

UNIT – IV

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

UNIT – V

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, Interaction analysis, and pile raft system, solutions through influence charts.

Text Books:

1. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.
2. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, basic geo-techniques (6^{th} Edition), Prentice Hall, 2002.
3. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
4. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.

Reference Books:

1. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.
2. Scott, R.F. Foundation Analysis, Prentice Hall, 1981.
3. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Dehit, 1988.

Course Title	GROUND IMPROVEMENT TECHNIQUES				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851104	PE-1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To study the problems associated with problematic geo-materials and the methods for their improvement to support buildings and various types of structures

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	At the completion of the course the students will be able to understand the different types of ground modification can be done depending upon the site condition, type and purpose of structure to be constructed.

UNIT – I

Dewatering: Introduction - Scope and necessity of ground improvement in Geotechnical engineering- basic concepts and philosophy, Drainage - Ground Water lowering by well points deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques

UNIT – II

Compaction and Sand Drains: In-situ compaction of granular and cohesive soils, Shallow and Deep compaction sand piles – concept, design, factors influencing compaction Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – theories of sand drain – design and relative merits.

UNIT – III

Stone Column, Lime Piles and Soil Nailing: Stone column, lime piles – Functions – Methods of installation – design, estimation of load carrying capacity and settlement-slope stability-stability of trenches-lime-sand columns-Root piles, soil nailing – Applications.

UNIT – IV

Earth Reinforcement: Earth reinforcement – Principles and basis mechanism of reinforced earth-reinforced soil retaining structures-simple design, Synthetic and natural fibre based Geo-textiles and their applications. Filtration, drainage, separation, erosion control – case studies

UNIT – V

Grouting: Grouting techniques – Types of grout – Suspension and solution grouts – Basic requirements of grout, Grouting equipment – principle of injection-injection methods – properties of treated ground-application of jet grouting-grout monitoring – Electro – chemical stabilization – Stabilization with cement, lime etc. – Stabilization of expansive clays.

Text Books:

1. Dr. P. Purushothama Raj., "Ground Improvement Techniques", Lakshmi Publications Pvt. Ltd.
2. Das, B.M., Principles of Foundation Engineering, (Fourth Edition). PWS Publishing, 1999
3. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1985.
4. Koerner, R.M. and Welsh, J.P., Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, 1990.

Reference Books:

1. Moseley, M.D., Ground Treatment, Blackie Academic and Professional, 1998.
2. Hehn, R.W., Practical Guide to Grouting of Underground Structures, ASCE, 1996.
3. Koerner, R.M., Designing with Geosynthetics (Third Edition), Prentice Hall, 1997.

Course Title	PAVEMENT ANALYSIS AND DESIGN				M.Tech GTE I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851105	PE-1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To understand the different types of pavements.
- To conduct analysis of flexible pavements for stresses, strains, and deflections in one-, two-, and three-layered systems.
- To design flexible pavements using the AASHTO design procedure.
- To conduct analysis of rigid pavements for stresses, strains, and deflections.
- To design rigid pavements using the AASHTO design procedure.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students will be able to design flexible as well rigid pavements.

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 method 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 method of design; Design of continuously reinforced concrete pavements.

Text Books:

1. Yang H Huang - Pavement Analysis and Design, 2nd Edition, Pearson Education
2. KhannaS.K & Justo C.E.G – Highway Engineering, Khanna Publishers.
3. Srinivasa Kumar R – Pavement design, University press (India) Pvt. Ltd 2013

Reference Books:

1. Design and Specification of Rural Roads (Manual), Ministry of Rural Roads, Government of India, New Delhi, 2001
2. Yoder R.J And Witchakm.W., Principles of Pavement Design, John Wiley, 2000.
3. Guidelines for the Design of Flexible Pavements, IRC: 37 - 2001, the Indian Roads Congress, New Delhi.
4. Guideline for the Design of Rigid Pavements for Highways, IRC: 58-1998, the Indian Roads Congress, New Delhi.

Course Title	FEM IN GEO-MECHANICS				M.Tech GTE I Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851106	PE-2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To explain the basic concepts of FEM
- To explain the principles and formulation of variational methods
- To analyse the displacements and explain the problems in soils and rocks
- To explain the applications of FEM in geotechnical engineering

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can understand basic stress-strain relationship for soil and develop Stress deformation analysis.
CO 2	Students can develop finite element formulation for different geotechnical problems including shallow foundation, seepage and consolidation problems.

UNIT – I

Basic Concepts: Basic concepts - Discretization of continuum, typical elements, the element characteristic matrix, Element assembly and solution for unknowns - Applications.

UNIT – II

Variational Principles: Variational principles, variational formulation of boundary value problems, Variational methods approximation such as Ritz and weighted residual (Galerkin) methods, Applications.

UNIT – III

Displacements Based Elements: Displacements based elements, finite elements for axial symmetry. One-dimensional problems of stress, deformation and flow, Assembly, Convergence requirements, Finite elements analysis of two-dimensional problems. The linear and quadratic triangle, Natural coordinates.

UNIT – IV

Iso-parametric Formulation: Application of FEM to Problems in soils and rocks, Introduction to non-linearity, Finite difference method, Description and application to consolidation, seepage, Winkler foundation etc.,

UNIT – V

Applications in Geotechnical Engineering: Application of FEM to Problems in soils, Introduction to non-linearity, Finite difference method, Description and application to consolidation, seepage, Winkler foundations.

Text Books:

1. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu., Introduction to Finite Elements in Engineering, Prentice- Hall, 1991.
3. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheller Publishing, Allahabad, 1993.
4. Smith, I.M., Programming the Finite Element Method with Application to Geomechanics, John Wiley and sons, New Delhi, 2000.

Reference Books:

1. Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and Applications of Finite Element Analysis, John Wiley, 1989.
2. Gupta, O.P. Finite and Boundary Element Methods in Engineering, Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi, 2000.
3. Potts, D.M. and Zdramcovic, L., Finite Element analysis in Geotechnical Engineering - Application, Thomas Telford, 2001.

Course Title	ENVIRONMENTAL GEO-TECHNOLOGY				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851107	PE-2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To learn concepts of geo-environmental engineering, and planning and design of waste in landfills, ash ponds and tailing ponds.
- Explain the effects of pollutants in soil properties
- Awareness about the adverse effects of soil and ground water contaminants
- Analyse and apply the various techniques for remediation of the contaminants

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can understand Soil-environment interaction, Soil mineralogy and Mechanisms of soil-water interaction
CO 2	Students can lean ground water flow and predict contaminant transport phenomenon. Can apply remediation techniques for contaminated site.

UNIT – I

Introduction: Industrialization and Urbanization, Pollution, Control and remediation.

Contamination: Surface contamination, Contamination transport, Soil-a Geotechnical trap, Effect of subsurface contamination, Detection of polluted zone, Monitoring and Effectiveness of designed facilities.

UNIT – II

Contaminants of Solid Waste in Landfills: Waste contaminants, landfills, types, shape and size of landfills. Liner and liner system, Cover and cover system, Stability of landfills. Landfill construction & operation, sustainable waste management.

UNIT – III

Contaminants of Slurry wastes: Slurry transported wastes, slurry ponds, operation, Embankment construction and raising, Design aspects, Environmental Impact and control.

UNIT – IV

Vertical Barriers for Contaminant: Contaminated sites, Types of barriers, Soil-Bentonite slurry trench walls, Cement-Bentonite slurry trench walls, construction, material and design aspects.

UNIT – V

Geotechnical Reuse of Waste materials: Waste reduction, use in geotechnical construction, waste characteristics, transportation consideration, Engineering properties of Wastes, Waste material in Embankment and Fills.

Text Books:

1. Geo-environmental Engineering by Sharma H.D & Reddy K.R
2. Geo-environmental Engineering by ReddiL.N & Inyang.H.I
3. Geo Technical Practice for Waste Disposal by Daniel.D.EWentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
4. Fried, J.J., Ground Water Pollution, Elsevier, 1975.

Reference Books:

1. Geotechnical Geo – Environmental Engineering hand Book – Kerry Row
2. Ground Water Contamination: Bedient, Refai & Newell.
3. Daniel, B.E., Geotechnical Practice for waste disposal, Chapman and Hall, London, 1993.
4. Proceedings of the International symposium of Environmental Geo-technology (Vol.I and II), Environmental Publishing Company, 1986 and 1989.
5. ASTM Special Technical Publication 874, Hydraulic Barrier in Soil and Rock, 1985.

Course Title	CRITICAL SOIL MECHANICS					M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851108	PE-2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To demonstrate basic mechanisms behind index properties and tests on soil, relate behaviour of soils subjected to various loading and drainage conditions within unified framework of Critical state soil mechanics.
- To analyse theory of elasticity and plasticity to characterize the stress – strain behaviour of soils and to formulate basic elasto-plastic model based on Critical State Soil Mechanics (CSSM) like Cam-clay.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	At the completion of the course the students will be able to decide the type of mathematical models to be used for analyzing the behavior of soil mass at critical state.

UNIT – I

Soil Behavior: State of Stress and Strain in Soils, Stress and Strain Paths and Invariants, Behavior of Soils under Different Laboratory Experiments

UNIT – II

The Critical State Line and the Roscoe Surface: Families of Undrained Tests, Families of Drained Tests, The Critical State Line, Drained and Undrained Surfaces, The Roscoe Surface

UNIT – III

Behavior of Overconsolidated Samples: The Hvorslev Surface: Behaviour of Overconsolidated Samples, Drained and Undrained Tests, The Hvorslev Surface, Complete State Boundary Surface, Volume Changes and Pore Water Pressure Changes

UNIT – IV

Behaviour of Sands: The Critical State Line for Sands, Normalized Plots, The Effect of Dilation, Consequences of Taylor's Model.

UNIT – V

Behaviour of Soils before Failure: Elastic and Plastic Deformations, Plasticity Theory, Development of Elastic-Plastic Model Based on Critical State Soil Mechanics, The Cam-Clay Model, The Modified Cam-Clay Model

Text Books:

1. J. H. Atkinson and P. L. Bransby, "The Mechanics of Soils: An Introduction to Critical State Soil Mechanics", Mcgraw Hill, 1978

Reference Books:

1. D. M. Wood, "Soil Behaviour and Critical State Soil Mechanics", Cambridge University Press, 1990
2. B. M. Das, "Fundamental of Geotechnical Engineering", Cengage Learning, 2013.

Course Title	RESEARCH METHODOLOGY & IPR				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851109	MLC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	2	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs		

Course Objectives:

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Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand research problem formulation.
CO 2	Analyze research related information, Follow research ethics
CO 3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO 4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO 5	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

UNIT – I

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

UNIT – II

Effective literature studies approaches, analysis Plagiarism, Research ethics,

UNIT – III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT – IV

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

UNIT – V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
- Mayall , "Industrial Design", McGraw Hill, 1992.
- Niebel , "Product Design", McGraw Hill, 1974.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Title	SOIL MECHANICS – 1 LABORATORY				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851110	LAB-1	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	4	2	50	50	100
					End Exam Duration: 3Hrs			

Course Objectives:

- To estimate index properties of soils (coarse and fine),
- To estimate consistency limit of fine grained soils.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Classify soil by physical observation of the soils.
CO 2	Carry out interpolation among the estimated soil design parameters.

List of Experiments:

1. Determination of Moisture Content and Specific Gravity of Soil
2. Grain Size Distribution Analysis and Hydrometer Analysis
3. Atterberg Limits (Liquid Limit, Plastic Limit, Shrinkage Limit)
4. Visual Classification Tests
5. Vibration Test for Relative Density of Sand
6. Standard and Modified Proctor Compaction Test
7. Falling Head Permeability Test and Constant Head Permeability Test
8. Consolidation Test

Course Title	SOIL MECHANICS – 2 LABORATORY				M.Tech GTE I Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851111	LAB-2	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	4	2	50	50	100
					End Exam Duration: 3Hrs		

Course Objectives:

- To estimate shear strength of soils by direct shear test and unconfined compressive test
- To estimate the engineering properties of the soils by density test, CBR, permeability test.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Classify soil based on estimated engineering characteristics of soils
CO 2	Carry out interpolation among the estimated soil design parameters

List of Experiments:

1. Unconfined Compression Test
2. Direct Shear Test
3. Tri-Axial Compression Test – UU, CU, CD Tests
4. Laboratory Vane Shear Test
5. Field Vane Shear Test
6. Field Direct Shear Test

M.TECH.-II- SEMESTER SYLLABUS

Course Title	DYNAMICS OF SOIL AND FOUNDATIONS				M.Tech GTE II Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851201	CORE-3	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To study vibration concepts in soils like damping, wave propagation, resonance and effect of modes of vibrations
- To study dynamic soil properties. Determination of dynamic properties by field and laboratory tests
- Effect of liquefaction and antiliquifaction measures
- To study vibration isolation, machine foundation design

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students understand theory of vibration and resonance phenomenon, dynamic amplification.
CO 2	Students understand propagation of body waves and surface waves through soil.
CO 3	Student exposed to different methods for estimation of dynamic soil properties required for design purpose.
CO 4	Students can predict dynamic bearing capacity and assess liquefaction potential of any site.
CO 5	Students apply theory of vibrations to design machine foundation based on dynamic soil properties and bearing capacity

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 - Types of damping - Equivalent stiffness of springs in series and parallel - Principles of vibration measuring devices

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. Swami Saran - Soil Dynamics and Machine Foundation, Galgotia Publications Pvt. Ltd. (2010)
2. Prakash, S. - Soil Dynamics, McGraw Hill Book Company (1981)

Reference Books:

1. I.Chowdhary and S P Dasgupta - Dynamics of Structures and Foundation, 2009.
2. Prakash, S. and Puri, V. K. - Foundation for Machines: Analysis and Design, John Wiley & Sons, 1998.
3. KameswaraRao, N. S. V. - Vibration Analysis and Foundation Dynamics, Wheeler Publication Ltd., 1998.
4. Das, B. M. - Principles of Soil Dynamics, PWS KENT publishing Company, Boston.2002.

Course Title	SUBSURFACE INVESTIGATIONS AND INSTRUMENTATION				M.Tech GTE II Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851202	CORE-4	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To identify the soil type of soil from a job site or in a professional setting, determine that soil's properties based on type and evaluate design decisions from your understanding of that soil's properties.
- To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can plan subsurface investigation based on the requirement of civil engineering project and site condition. Can finalize depth and number of boreholes
CO 2	Students can execute different subsurface exploration tests, collect disturbed / undisturbed samples for laboratory tests and can suggest design parameters.
CO 3	Student exposed to different methods for estimation of dynamic soil properties required for design purpose.
CO 4	Students can develop instrumentation scheme for monitoring of critical sites

UNIT – I

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

UNIT – II

Open Excavation and Borings of Exploration: Pits and Trenches – Drifts and Shafts – Methods of boring – Auger Borings – Wash Borings –Rotary Drilling –Percussion Drilling – Core Drilling.

UNIT – III

Soil Samples and Samplers: Types of soil samples – Disturbed samples –Undisturbed samples – Design features affecting the sample disturbance –Split spoon samplers – Scraper Bucket Samplers –Shell by Tubes and Thin walled Samplers – Piston Samplers – Denis Samplers – Preservation and handling of samples.

UNIT – IV

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

UNIT – V

Geophysical Methods: Types–Electrical Resistivity Methods – Electrical Profiling Method – Electrical Sounding Method – Seismic Methods – Seismic refraction method – Sub-soil Investigation Report.

Mechanical Wave Measurements: Crosshole Tests (CHT), Downhole Tests (DHT), Spectral Analysis of Surface Waves, Seismic Refraction, Suspension Logging::Electromagnetic Wave Techniques: Ground Penetrating Radar (GPR), Electromagnetic Conductivity (EM), Surface Resistivity (SR), Magnetometer Surveys (MT)

Text Books:

1. V.N.S. Murthy, Soil Mechanics & Foundation Engineering, Vol. 2, Sai Kripa Technical Consultants, Bangalore
2. C. Venkataramaiah, Geotechnical Engineering, Wiley Eastern Ltd., New Delhi

Reference Books:

1. Hvorslev, MJ, Sub Surface Exploration and Sampling of Soils for Civil Engineering Purpose, Water-ways Station, Vicksburg, Mississippi, 1949.
2. Noel Simons, Bruce Menzies and Marcus Matthews, A Short Course in geotechnical Site Investigation, Thomas Telford.
3. SP36- Compendium of Indian Standards on Soil Engineering - Part –II
4. Dobrine, Geophysical methods

Course Title	OFFSHORE GEO-TECHNICAL ENGINEERING				M.Tech GTE II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851203	PE-3	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs		

Course Objectives:

- To analyze distribution of marine sediments along the Indian coasts.
- To analyze geotechnical challenges in case of marine sediments
- To implement in-situ testing procedures for determining the properties of marine clays.
- To analyze behavior of marine soil deposits under repetitive loading conditions

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can execute investigation program for marine soil deposits and select necessary design parameters. Design suitable marine foundation as per project requirement. Can develop numerical model for response of marine foundation for offshore conditions

UNIT – I

Marine Soil Deposits: Offshore Environment, Offshore Structures and Foundations, Specific Problems Related to Marine Soil Deposits, Physical and Engineering Properties of Marine Soils.

UNIT – II

Behavior of Soils Subjected to Repeated Loading: Effect of Wave Loading on Offshore Foundations, Behavior of Sands and Clays Under Cyclic Loading, Laboratory Experiments Including Repeated Loading, Cyclic Behavior of Soils Based on Fundamental Theory of Mechanics, Approximate Engineering Methods which can be used for Practical Cases.

UNIT – III

Site Investigation in the Case of Marine Soil Deposits: Challenges of Site Investigation in Marine Environment, Different Site Investigation Techniques, Sampling Techniques, Geophysical Methods, Recent Advancements in Site Investigation and Sampling used for Marine Soil Deposits.

UNIT – IV

Foundations in Marine Soil Deposits: Different Offshore and Nearshore Foundations, Gravity Platforms, Jack-Up Rigs, Pile Foundations. Cassions, Spudcans.

UNIT – V

Numerical Modeling of Marine Foundations Subjected to Wave Loading: Numerical Modeling of Cyclic Behavior of Soils, Empirical Models, Elastic-Plastic Models, Fem Analysis of Marine Foundations Subjected to Wave Loading.

Text Books:

1. H. G. Poulos. "Marine Geotechnics", Unwin Hyman Ltd, London, UK, 1988

Reference Books:

1. D. V. Reddy And M. Arockiasamy, "Offshore Structures", Volume: 1, R.E. Kreiger Pub And Co., 1991
2. D. Thomson And D. J. Beasley, "Handbook of Marine Geotechnical Engineering", US Navy, 2012

Course Title	COMPUTATIONAL GEO-MECHANICS				M.Tech GTE II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851204	PE-3	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs		

Course Objectives:

- To analyse linear and non-linear equations using numerical techniques.
- To apply finite difference and finite element method for analysing behaviour of geotechnical structures.
- To apply correlation and regression analysis for the geotechnical data.
- To solve problem of consolidation and flow through porous media using numerical technique.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can understand different numerical and statistical tools for analyzing various geotechnical engineering problems.
CO 2	Students can apply probabilistic approach for selection of design parameters and compute their impact on risk assessment

UNIT – I

Solution of Non-Linear Equations: Bisection, False Position, Newton-Raphson, Successive Approximation Method, Iterative Methods

Solution of Linear Equations: Jacobi's Method, Gauss Seidal Method, Successive over Relaxation Method.

UNIT – II

Finite Difference Method: Two Point Boundary Value Problems – Disichlet Conditions, Neumann Conditions; Ordinary and Partial Differential Equations.

Finite Element Method: Fundamentals, Constitutive Finite Element Models for Soils.

UNIT – III

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

UNIT – IV

One-Dimensional Consolidation - Theory of Consolidation, Analytical Procedures, Finite Difference Solution Procedure for Multilayered Systems, Finite Element Formulation

UNIT – V

Flow through Porous Media - Geotechnical Aspects, Numerical Methods, Applications and Design Analysis, Flow in Jointed Media.

Risk Assessment in Geotechnical Engg. - Probabilistic Site Characterisation and Design of Foundations.

Text Books:

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computations", Third Edition, New Age International (P) Ltd. Publishers, New Delhi.

Reference Books:

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

Course Title	ENGINEERING ROCK MECHANICS				M.Tech GTE II Sem			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851205	PE-3	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To identify type of the rock, analyse the rock quality designation and also evaluate its strength, and to determine the methods of tunnelling and mining.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students will be able to perform various laboratory tests on rock and classify rock mass. Be able to predict strength of rock mass with respect to various Civil Engineering applications.

UNIT – I

Rock: Formation of Rocks, Physical Properties, Classification of Rocks and Rock Masses, Elastic Constants of Rock; In-situ Stresses in Rock

Rock Testing: Laboratory and Field Tests.

UNIT – II

Discontinuities in Rock Masses: Discontinuity Orientation, Effect of Discontinuities on Strength of Rock.

UNIT – III

Strength Behaviour: Compression, Tension and Shear, Stress-Strain Relationships, Rheological Behavior.

UNIT – IV

Strength/ Failure Criterion: Mohr-Coulomb, Griffith Theory, Hoek and Brown, Strength and other Strength Criteria. Stresses in Rock near Underground Openings;

UNIT – V

Application of Rock Mechanics in Civil Engineering: Rock Tunneling, Rock Slope Stability, Bolting, Blasting, Grouting and Rock Foundation Design. Modern Modelling Techniques & Analyses in Rocks.

Text Books:

1. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: An Introduction to the Principles, 1997. Elsevier, Oxford
2. Goodman, R.E. Introduction to Rock Mechanics, John Wiley & Sons.
3. Ramamurthy, T., “Engineering in Rocks”, Phi Learning Pvt. Ltd.

Reference Books:

1. Jaeger, J.C. and Cook, N.G.W, Fundamentals of Rock Mechanics, Chapman and Hall, 1976.
2. Wyllie, D.C., Foundations on Rock, E & Fn Spon. 2nd Edition, 1992.

Course Title	EARTH RETAINING STRUCTURES				M.Tech GTE II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851206	PE-4	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To calculate earth pressure on various earth retaining structures such as gravity retaining walls, sheet pile, bulkheads, bracing/struts and coffer dams, design a relevant earth retaining structure for given soil condition, design of sheet pile with and without anchors, and to design the reinforced wall by using different materials

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students will be able to do analysis and design of different types of retaining structures.

UNIT – I

Earth Pressure Theories: Introduction – State of stress in retained soil mass – Earth pressure theories – Analytical and graphical techniques – Active and passive cases – Earth pressure due to homogeneous and layered backfills, uniform surcharge, uniformly sloping surcharge and randomly positioned surcharges, - Empirical methods – Wall movement and complex geometry.

UNIT – II

Drainage and Stability Considerations: Lateral pressure due to compaction, strain softening, wall flexibility – influence of drainage – Earth pressure due to earthquake forces – Stability of retaining structures.

UNIT – III

Sheet Pile Walls: Retaining structure – Selection of soil parameters – Analysis and design of cantilever and anchored sheet pile walls – Deadman and continuous anchors – Diaphragm and bored pile walls – Design requirements

Caissons: Types – Stability of caissons – principles of analysis and design – seismic influences - IRC Guidelines.

UNIT – IV

Supported Excavations: Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving - Earth pressure around tunnel lining, shaft and silos.

UNIT – V

Design of Reinforced Earth Retaining Wall: Reinforced earth retaining wall – principles, Concepts and mechanism of reinforced Earth – Design consideration of reinforced earth – Materials used in reinforced earth - Geotextile – Geo-grids, Metal strips, facing elements.

Text Books:

1. Koerner, R.M., Design with Geosynthetics (Third Edition), Prentice Hall, 1997.
2. Das, B.M., Principles of Geotechnical Engineering (Fourth Edition). The PWS series in Civil Engineering, 1998
3. Mandal, J.N., Reinforced Soil and Geo-textiles, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. J E Bowles, Foundation Engineering to add this text book

Reference Books:

1. Winterkorn, H.F. and Fang, Y.F., Foundation Engineering Handbook, Van Nostrand Reinhold, 1994.
2. Day, R.W., Geotechnical and Foundation Engineering, Design and Construction, McGraw Hill 1999.
3. McCarthy, D.F., Essentials of Soil Mechanics and Foundations: Basic Geo-techniques (Sixth Edition), Prentice Hall, 2002.
4. Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992.

Course Title	DESIGN OF UNDERGROUND EXCAVATIONS				M.Tech GTE II Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851207	PE-4	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To know the planning and exploration of various underground projects, analyse the stress distribution, analyse the rock quality designation and also evaluate its strength
- To analyse the interaction between the rock mass and tunnel surface

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can understand the use of elastic and plastic analysis in the design of underground support system.
CO 2	Students will have idea about the field tests generally conducted during and after construction of under structures.

UNIT – I

Introduction, Planning and Exploration for Various Underground Construction Projects, Stereographic Projection Method, Principle and its Application in Underground Excavation Design.

UNIT – II

Elastic Stress Distribution around Tunnels, Stress Distribution for Different Shapes and Under Different In-Situ Stress Conditions, Greenspan Method, Design Principles, Multiple Openings, Openings in Laminated Rocks, Elasto-Plastic Analysis of Tunnels, Daemen's Theory.

UNIT – III

Application of Rock Mass Classification Systems, Ground Conditions in Tunneling, Analysis of Underground Openings in Squeezing and Swelling Ground, Empirical Methods, Estimation of Elastic Modulus and Modulus of Deformation of Rocks; Uniaxial Jacking / Plate Jacking Tests, Radial Jacking and Goodman Jacking Tests, Long Term Behaviour of Tunnels and Caverns, New Austrian Tunneling Method (Natm), Norwegian Tunneling Method (Ntm), Construction Dewatering.

UNIT – IV

Rock Mass-Tunnel Support Interaction Analysis, Ground Response and Support Reaction Curves, Ladanyi's elasto-Plastic Analysis of Tunnels, Design of Various Support Systems Including Concrete and Shotcrete Linings, Steel Sets, Rock Bolting and Rock Anchoring, Combined Support Systems, Estimation of Load Carrying Capacity of Rock Bolts.

UNIT – V

In-Situ Stress, Flat Jack, Hydraulic Fracturing and Over Coring Techniques and USBM type Drill Hole Deformation Gauge, Single and Multi-Point Bore Hole Extensometers, Load Cells, Pressure Cells, etc. Instrumentation and Monitoring of Underground Excavations, During and After Construction, Various Case Studies.

Text Books:

1. Hoek, E and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering.
2. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.

Reference Books:

1. Singh, B. and Goel, R.K., "Rock Mass Classification - A Practical Engineering Approach", Elsevier.
2. Singh, B. and Goel, R.K., "Tunnelling in Weak Rocks", Elsevier

Course Title	PHYSICAL AND CONSTITUTIVE MODELING ON GEO-MECHANICS				M.Tech GTE II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851208	PE-4	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To understand the concept of linear, quasi linear concept, basics of plasticity in soils,
- To analyse theory of elasticity and plasticity to characterize the stress – strain behaviour of soils and to formulate basic elasto-plastic model based on Critical State Soil Mechanics (CSSM) like Cam-clay
- To understand the concept of consolidation, formulation and implementation of plasticity theory.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students can understand theory of plasticity and various yield criteria and flow rule.
CO 2	Students can apply critical state concept to consolidation and triaxial soil behaviour.

UNIT – I

Role of Constitutive Modeling; Importance of Laboratory Testing with Relation to Constitutive Modeling; Elasticity: Linear, Quasi Linear, Anisotropic;

UNIT – II

Plasticity Basics: Yield Criteria, Flow Rule, Plastic Potential, Hardening/Softening; Rate Independent Plasticity: Mohr-Coulomb, Nonlinear Failure Criteria, Drucker Prager, and Cap Models;

UNIT – III

Critical State Soil Mechanics: Critical State Concept, Cam Clay Models, Simulation of Single Element Test Using Cam Clay,

UNIT – IV

Consolidation, Drained and Undrained Triaxial Test; Stress Dilatancy Theory;

UNIT – V

Work Hardening Plasticity Theory: Formulation and Implementation; Applications of Elasto-Plastic Models; Special Topics: Hypoelasticity-Plasticity, Disturbed State Concept.

Text Books:

1. Hicher and Shao, “Constitutive Modeling of Soils and Rocks”, John Wiley. 2008
2. C.S. Desai and H. J. Siriwardane, “Constitutive Laws for Engineering Materials with Emphasis on Geologic Materials”, Prentice-Hall, Inc., New Jersey. 1984
3. David M Potts and Lidijazdravkovic, “Finite Element Analysis in Geotechnical Engineering Theory and Application”, Thomas Telford. 1999

Reference Books:

1. C.S. Desai, “Mechanics of Materials and Interfaces: The Disturbed State Concept”, CRC Press Ltd. 2000
2. A.P.S. Selvadurai, M.J. Boulon, “Mechanics of Geomaterial Interfaces, Elsevier.

Course Title	MINI PROJECT					M.Tech GTE II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851209	PROJECT	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	4	2	100	--	100
Internal Assessment								

<table>
<tr><td colspan="2">Course Title</td><td colspan="4">SUB SOIL EXPLORATION LABORATORY</td><td colspan="3">M.Tech GTE II Sem</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">1851210</td><td rowspan="2">LAB-3</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exams</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="5"></td><td colspan="4">End Exam Duration: 3Hrs</td></tr>
<tr><td colspan="9">Course Objectives:
• To estimate the load carrying capacity and soil profile</td></tr>
<tr><td colspan="9">Course Outcomes: On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Classify soil based on the collection of soil by borings</td></tr>
<tr><td>CO 2</td><td colspan="8">Design the suitable foundation based upon the load carrying capacity of the soil</td></tr>
<tr><td>CO 3</td><td colspan="8">Carry out interpolation among the estimated soil design parameters</td></tr>
</table>

List of Experiments:

Exploratory Borings by Different Methods Including Auger Boring, Wash Boring, Percussion Drilling and Rotary Drilling.

1. Standard Penetration Test
2. Dynamic Cone Penetration Test
3. Static Cone Penetration Test
4. Plate Load Test
5. Pressure Meter Test
6. Geophysical Exploration Tests

<table>
<tr><td>Course Title</td><td colspan="5">GEO-TECHNICAL ENGINEERING MODELING LABORATORY</td><td colspan="3">M.Tech GTE II Sem</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">1851211</td><td rowspan="2">LAB-4</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exams</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="5"></td><td colspan="4">End Exam Duration: 3Hrs</td></tr>
<tr><td colspan="9">Course Objectives:
• To estimate the safe slope, load carrying capacity.</td></tr>
<tr><td colspan="9">Course Outcomes: On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Design suitable slope, pile for both static and dynamic conditions.</td></tr>
</table>

List of Experiments:

1. Slope Modeling
2. Sigma modelling
3. Quake modelling
4. Analysis of slope by Fellenius, Bishop and Janbu method
5. Boussinesq analysis for displacement due to loads
6. Mindlin analysis for displacement due to loads
7. Analysis of pile (capacity, end bearing, bearing capacity and settlement)
8. Analysis of one-dimensional soil column to an earthquake motion

Software:

1. GeoStudio
2. Oasys – Geo Suite

M.TECH.-III- SEMESTER SYLLABUS

Course Title	STABILITY ANALYSIS OF SLOPES				M.Tech GTE III Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851301	PE-5	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To introduce the concepts of slope stability, introduce the concepts of slope stability analyses using simplified methods, and to describe some of the sophisticated methods of slope stability analyses.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Student will be able to check the stability of earthen dams, and the safety measures to be undertaken to prevent the instability of slopes, earthen dams and embankments.

UNIT – I

Slopes: Types and Causes of Slope Failures, Mechanics of Slope Failure, Failure Modes.

UNIT – II

Stability Analysis: Infinite and Finite Slopes with or Without Water Pressures; Concept of Factor of Safety, Pore Pressure Coefficients, Mass Analysis, Wedge Methods, Friction Circle Method; Method of Slices, Bishop's Method, Janbu's Method, Morgenstern And Price, Spencer's Method.

UNIT – III

Stability Analysis in the Presence of Seepage: Two Dimensional Flow – Laplace Equation and it's Solution, Graphical Method, Determination of Phreatic Line, Flow Nets in Homogeneous and Zoned Earth Dams under Steady Seepage and Draw-Down Conditions, Seepage Control in Earth Dams, Influence of Seepage on Slope Stability Stability Analysis of Dam Body During Steady Seepage.

UNIT – IV

Strengthening Measures: Stabilization of Slopes by Drainage Methods, Surface and Subsurface Drainage, Use of Synthetic Filters, Retaining Walls, Stabilization and Strengthening of Slopes, Shotcreting, Rock Bolting and Rock Anchoring, Instrumentation and Monitoring of Slopes, Slope Movements, Warning Devices, Maintenance of Slopes

UNIT – V

Case studies of urban slope stability: Aims, Regional perspective, Landslide inventory, Stability analyses of three sites, Case study 1 – Site 64 in the suburb of Scarborough, Case study 2 – Site 77, Morrison Avenue – Wombarra, Case study 3 – Site 134, Woonona Heights, Concluding remarks on the three case studies, Landslide-triggering rainfall, Landslide susceptibility and hazard, Observational approach and monitoring.

Text Books:

1. Chowdhary R Phil Flentje and Bhattacharya G, "Geotechnical Slope Analysis", CRC Press.
2. YM Cheng and CK lau, "Slope Stability Analysis and Stabilization", CRC Press.

Reference Books:

1. Harr M.E., "Ground Water and Seepage", McGraw Hill. 1962

Course Title	FOUNDATION ON WEAK ROCKS				M.Tech GTE III Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851302	PE-5	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs		

Course Objectives:

- To study the properties of weak rock and classification, analyse the effect of structural planes, study the requirements of satisfactory performance of foundation and analyse the pile on weak rock.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	The students will be able to classify different types of rock mass and design different types of foundations placed over rock mass.

UNIT – I

Engineering Properties of Weak Rocks, Different Rock Mass Classification Systems, Relative Merits and Demerits, Failure Criteria for Weak Rocks, Bi-Linear Mohr-Coulomb Failure Criterion, Hoek and Brown Criterion and Modified Hoek and Brown Failure Criterion Etc.

UNIT – II

Effect of Structural Planes on Rock Foundations, Possible Modes of Failure of Foundations on Rocks/ Rock Masses, Determination of In-Situ Shear Strength of Rocks and Rock Masses

UNIT – III

Requirements for Satisfactory Performance of Foundations, Bearing Capacity of Foundations on Rocks and Rock Masses, Allowable Bearing Pressure of Rock Foundations Using a Nonlinear Failure Criterion, Monotonic and Cyclic Plate Load Tests, Pressure-Settlement Characteristics, Effect of Layering, Anisotropy, Heterogeneity and Inelasticity

UNIT – IV

Shallow Foundations, Shallow Foundations on Sloping Ground, Raft Foundations, Stilt Foundations, Foundations for Suspension Bridges, Transmission Line Towers, Framed Buildings etc, Treatment of Foundations - Open Joints, Solution Cavities, Weak Seams.

UNIT – V

Piles in Weak Rocks, Bearing Capacity and Settlement of Piles, Piles in Stratified Rock Masses, Field Load Tests on Piles in Weak Rocks, Behaviour of Bored / Driven Piles in Soft / Weathered Rocks.

Text Books:

1. Singh, B. and Goel, R.K., "Rock Mass Classification- A Practical Engineering Approach", Elsevier.
2. Ramamurthy, T., "Engineering In Rocks", PHI Learning Pvt. Ltd.
3. Hoek, E., "Practical Rock Engineering", Rock Science.

Reference Books:

1. Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E & Fn Spon, Taylor And Francis.
2. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: An Introduction to the Principles, 1997. Elsevier, Oxford

Course Title	GEO-TECHNICAL EARTHQUAKE ENGINEERING				M.Tech GTE III Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1851303	PE-5	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To determine size of earthquake and strong ground motion parameters from a recorded seismogram or accelerogram.
- To analyse deterministic or probabilistic seismic hazard analysis considering the different soil properties and site conditions
- To study principles of wave propagation through rocks and soil media to derive transfer functions for ground response analysis.
- To analyze liquefaction susceptibility of a site and determine factor of safety against liquefaction.
- To design earthquake resistant geotechnical structures like shallow and deep foundations, retaining walls, slopes

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students will know the causes and quantification of earthquake.
CO 2	Student will be exposed to the effect of earthquake and the design criterions to be followed for the design different geotechnical structures.

UNIT – I

Elements of Earthquake Seismology and Dynamics: Theory of vibration - Basic Definition - Governing equation for single degree freedom system - Forced vibrations - Rotating mass type excitation - Base excitation - Isolation vibration measuring instruments. Mechanism of Earthquakes - Causes of earthquake - Earthquake Fault sources - Elastic Rebound theory - Seismic wave in Earthquake shaking - Definition of earthquake terms - Locating an earthquake - Quantification of earthquakes.

UNIT – II

Ground Motion Characteristics: Strong Motion Records -characteristics of ground motion - Factors influencing ground motion - Estimation of frequency content parameters - (Seismic site investigations - Evaluation of Dynamic soil properties

UNIT – III

Ground Response Analysis - Local Site Effects and Design Ground Motion: Wave propagation Analysis - Site Amplification Need for Ground Response Analysis - Method of analysis - One Dimensional Analysis - Equipment linear Analysis site effects - Design Ground Motion - Developing Design Ground Motion

UNIT – IV

Seismic Stability Analysis: Earthquake - Resistant Design of foundation of buildings - Design considerations - Geotechnical - Architectural - Structures - Capacity Design - Seismic analysis. Earthquake Response of slopes - Evaluation of slope stability - Pseudostatic Analysis - Newmark's Study of Block Analysis - Dynamic Analysis - Earth pressure due to ground shaking Evaluation, Liquefaction-Susceptibility-Evaluation Cyclic stress approach -

Liquefaction Resistance - Laboratory and Field Tests with interpretation - Lateral Deformation - Case Study

UNIT - V

Earthquake Hazard Mitigation: Seismic risk vulnerability and hazard - Percept of risk - risk mapping - scale - hazard assessment - Maintenance and modifications to improve hazard resistance - Different type of foundation and its impact on safety - Ground Improvement Techniques.

Text Books:

1. Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.
2. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
3. Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.

Reference Books:

1. Shamsher Prakash and Vijay Kumar Puri., Foundations for Machines, John Wiley and Sons, New Delhi, 1988 .
2. “Earth Quake” W.H. Freeman, New York.

OPEN ELECTIVES

1. Business Analytics
2. Industrial Safety
3. Operations Research
4. Cost Management of Engineering Projects
5. Composite Materials
6. Waste to Energy

Course Title	BUSINESS ANALYTICS (Open Elective)					M.Tech GTE III Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1871304	OEC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

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

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students will demonstrate knowledge of data analytics.
CO 2	Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
CO 3	Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
CO 4	Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

UNIT II

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Text Books:

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press.

2. James Evans, "Business Analytics", persons Education.

3. Essentials of Business Analytics: An Introduction to the Methodology and its Applications, Bhimsankarm Pochiraju, Sridhar Seshadri, Springer.

Reference Books:

1. Business Analytics: Data Analysis and Decision Making, S. Christian Albright, Wayne L. Winstone, 6th Edition, Cengage Learning.

2. An Introduction to Business Analytics, Ger Koole, MG Books.

Course Title	INDUSTRIAL SAFETY (Open Elective)				M.Tech GTE III Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1871305	OEC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To Know about Industrial Safety Program, Fundamentals of Maintenance Engineering to understand Wear and Corrosion and their preventions.
- To Analyze Fault tracking, Periodic and preventive Maintenance.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Analyze the Industrial Safety, Drinking water layouts, fire prevention, etc
CO 2	Understand the Wear and Corrosion and their Preventions.
CO 3	Analyze faults in machine tools and their general causes.
CO 4	Understand Periodic and preventive maintenance

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Text Books:

1. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
2. H. P. Garg, S. Chand and Company, "Maintenance Engineering".
3. Audels, "Pump-hydraulic Compressors", Mcgrew Hill Publication.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London.

Reference Books:

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 2011.
2. Fawcett H.H and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd Edition, John Wiley and Sons inc.

Course Title	OPERATIONS RESEARCH (Open Elective)				M.Tech GTE III Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
1871306	OEC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs		

Course Objectives:

- To Apply various optimization Techniques for Decision Making.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Students should able to apply the dynamic programming to solve problems of discreet and continuous variables
CO 2	Students should able to apply the concept of non-linear programming
CO 3	Students should able to carry out sensitivity analysis
CO 4	Student should able to model the real world problem and simulate it

UNIT I

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

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

UNIT IV

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

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

Text Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
4. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

Reference Books:

1. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
2. Panner selvam, Operations Research: Prentice Hall of India 2010
3. Operations Research: Principles and Applications, G. Srinivasan, PHI.

Course Title	COST MANAGEMENT OF ENGINEERING PROJECTS (Open Elective)				M.Tech GTE III Sem		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exams	Total
1871307	OEC	3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- Understand the concepts of Project management for planning to execution of Projects.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand project characteristics and various stages of project.
CO 2	Analyze the learning and understanding techniques for project planning, scheduling and execution control.

UNIT I

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

UNIT II

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

UNIT III

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.

UNIT IV

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

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

Text Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

Reference Books:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co.
3. The Engineer's Cost Handbook, Richard E. Westney, P.E, CRC Press.

Course Title	COMPOSITE MATERIALS (Open Elective)				M.Tech GTE III Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1871308	OEC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- Train student on Composite materials-definition, Advantages and classification.
- Equip students with knowledge on composite strengthening addition of components and their production rules.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Identify and understand the behavior of composite materials
CO 2	Apply the choices made for using certain type of composites in certain applications with reference to composite properties.
CO 3	Analyze the manufacturing of metal matrix composites and polymer matrix composites.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Text Books:

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

Reference Books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Course Title	WASTE TO ENERGY (Open Elective)				M.Tech GTE III Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1871309	OEC	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hours					End Exam Duration: 3Hrs			

Course Objectives:

- To Create awareness in students of energy conservation.
- To Identify use of different types of Bio waste energy resources.
- To Understand different types of Bio waste energy conservations.
- To detect different waste conservation into different forms of energy.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand different types of energy from waste to produce electrical power.
CO 2	Estimate the use of bio waste to produce electrical energy.
CO 3	Understand different types of bio waste and its energy conversions.
CO4	Analyze the bio waste utilization and to avoid the environmental pollution.

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Text Books:

1. Biogas Technology- Transfer and Diffusion, M.M. Halwagi, Elsevier.
2. C. Y. WereKo-Brobby and E. B. Hagan, "Biomass Conversion and Technology", John Wiley & Sons, 1996.
3. Introduction to Biomass Energy Conservations, Sergio Capareda.

Reference Books:

1. Desai, Ashok V, "Non Conventional Energy", Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi, S. S, "Biogas Technology - A Practical Hand Book" -, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Challal, D. S., "Food, Feed and Fuel from Biomass", IBH Publishing Co. Pvt. Ltd., 1991.

Course Title	DISSERTATION STAGE-I				M.Tech GTE III Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1851310	MAJOR PROJ	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	20	10	100	--	100
Internal Assessment								

Course Objectives:

- Acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Demonstrate a technical knowledge of their selected project topic.
CO 2	Understand problem identification, formulation and solution.
CO 3	Communicate with engineers and the community at large in written an oral form.
CO 4	Demonstrate the knowledge, skills and attitudes of a professional engineer.

M.TECH.-IV- SEMESTER SYLLABUS

Course Title	DISSERTATION FINAL STAGE				M.Tech GTE IV Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1851401	MAJOR PROJ	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		0	0	32	16	50	50	100
Internal Assessment					External Assessment			

Course Objectives:

- Acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Demonstrate a technical knowledge of their selected project topic.
CO 2	Understand problem identification, formulation and solution.
CO 3	Communicate with engineers and the community at large in written an oral form.
CO 4	Demonstrate the knowledge, skills and attitudes of a professional engineer.

AUDIT COURSE-I & II SYLLABUS

Course Title	ENGLISH FOR RESEARCH PAPER WRITING (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
		L	T	P	C	Continuous Internal Assessment	End Exams	Total
1870A01	Audit Course	2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

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

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand Writing skills and level of Readability.
CO 2	Analyze what to write in each section.

UNIT I

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

UNIT II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

UNIT III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT IV

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V

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

Text Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Reference Books:

1. Adrian Wallwork, English for Academic Research: Grammar Usage and Style, Springer.

Course Title	DISASTER MANAGEMENT (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1870A02	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours							

Course Objectives:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand foundations of hazard, disasters and natural/social phenomena.
CO 2	Analyze Repercussions of disasters and hazards.
CO 3	Understand key concepts in disaster risk reduction and humanitarian response.

UNIT I

Introduction to Disaster: Definition, Factors and Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II

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

UNIT III

Disaster Prone Areas In India

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

UNIT IV

Disaster Preparedness and Management

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People'sParticipation In Risk Assessment. Strategies for Survival.

Disaster Mitigation

Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Reference Books:

1. Fundamentals of Disaster Management, Shekhawat R.S, Bhatnagar Harshul.
2. Disaster management, Ruthra, Lakshmi Publications.
3. Disaster Management and Preparedness, Nidhi Gauba Dhawan, Ambrina Sardar Khan, CBS Publishers.

Course Title	SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1870A03	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science &other subjects enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Understand Sanskrit grammar and Composition.
CO 2	Ancient Sanskrit literature about science & technology can be understood
CO 3	Being a logical language will help to develop logic in students

UNIT I

Alphabets in Sanskrit,
Past/Present/Future Tense,
Simple Sentences

UNIT III

Order
Introduction of roots
Technical information about Sanskrit Literature

UNIT III

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

Text Books:

1. Dr.Vishwas, "Abhyaspustakam" – Samskrita-Bharti Publication, New Delhi.

2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

3. Suresh Soni , "India's Glorious Scientific Tradition", Ocean books (P) Ltd., New Delhi.

Course Title	VALUE EDUCATION (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
1870A04	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Knowledge of self-development
CO 2	Learn the importance of Human values
CO 3	Developing the overall personality

UNIT I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
Moral and non- moral valuation. Standards and principles. Value judgments

UNIT II

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

UNIT III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking.
Integrity and discipline.
Punctuality, Love and Kindness.
Avoid fault Thinking.
Free from anger, Dignity of labour.
Universal brotherhood and religious tolerance.
True friendship.
Happiness Vs suffering, love for truth.
Aware of self-destructive habits.
Association and Cooperation.
Doing best for saving nature

UNIT IV

Character and Competence –Holy books vs Blind faith.
Self-management and Good health.
Science of reincarnation.
Equality, Nonviolence ,Humility, Role of Women.
All religions and same message.
Mind your Mind, Self-control.
Honesty, Studying effectively

Text Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.
2. John Haffai, Lead on & How to win over worry, World Book Publisher.
3. Swami Vivekananda, Call to the Youth for Nation Building, Advaita Ashrama, Calcutta.
4. Swami Vivekananda, Youth and Modern India, Rama Krishna Mission, Chennai.

Reference Books:

1. M.G. Chitakra, Education and Human values, A.P.H. Publishing corporation, New Delhi.

Course Title	CONSTITUTION OF INDIA (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1870A05	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

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

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Discuss the growth of the demand for civil right s in India for the bulk of Indians before the arrival of Gandhi in Indian politics
CO 2	Discuss the intellectual origins of the frame work of argument that informed the conceptualization of sociall reforms leading to revolution in India
CO 3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO 4	Discuss the passage of the Hindu Code Bill of 1956

UNIT I

History of Making of the Indian Constitution:

History, Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution:

Preamble, Salient Features

UNIT II

Contours of Constitutional Rights & Duties:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT III

Organs of Governance:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions

Executive:

President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT IV

Local Administration:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

Pachayati raj: Introduction, PRI: Zila Pachayat.

Elected officials and their roles, CEO Zila Pachayat: Position and role.

Block level: Organizational Hierarchy (Different departments),

Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT V

Election Commission:

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners.

State Election Commission: Role and Functioning.

Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:

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

Course Title	PEDAGOGY STUDIES (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1870A06	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

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

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
CO 2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO 3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT I

Introduction and Methodology:

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

UNIT II

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
Curriculum, Teacher education.

UNIT III

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

UNIT IV

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

Peer support

Support from the head teacher and the community.

Curriculum and assessment

Barriers to learning: limited resources and large class sizes

UNIT V

Research gaps and future directions

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

Text Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

Reference Books:

1. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
2. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.

Web Links:

1. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Title	STRESS MANAGEMENT BY YOGA (Audit Course)				M.Tech GTE I / II Sem		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
1870A07	Audit Course	L	T	P	C	Continuous Internal Assessment	End Exams	Total
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

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

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Develop healthy mind in a healthy body thus improving social health also
CO 2	Improve efficiency.

UNIT I

Definitions of Eight parts of yog. (Ashtanga)

UNIT II

- Yam and Niyam. Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III

- Asan and Pranayam

  i)Various yog poses and their benefits for mind & body

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

Text Books:

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature" .
3. Advaitashrama (Publication Department), Kolkata.
4. Acharya Yatendra, Yoga & Stress Management, Finger Print Publishing.

Course Title	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Audit Course)				M.Tech GTE I / II Sem		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**	
1870A08	**Audit Course**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exams**	**Total**
		2	0	0	0	40	--	40
Mid Exam Duration: 2 Hours								

Course Objectives:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
CO 2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity
CO 3	Study of Neetishatakam will help in developing versatile personality of students

UNIT I

Neetisatakam-Holistic development of personality

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

UNIT II

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT III

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

Text Books:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi.
3. Enlightenment: Personality Development and management, Sagir Ahmed, Independently Published.