DEPARTMENT OF CIVIL ENGINEERING

CBSC-AICTE STRUCTURE AND CURRICULUM

M.Tech. (Geotechnical Engineering)

PART TIME PROGRAMME

(Academic Year: 2018-19 Onwards)

Approved in XIX th Academic Council, dated 27/07/2018

Curriculum Structure for M. E. Civil-Soil Engineering

GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD

(An Autonomous Institute of Government of Maharashtra)

Department of Civil Engineering

M. Tech (Part-Time) in Geotechnical Engineering

(CBCS-AICTE Course-2018-19 Onwards)

Teaching and Evaluation Scheme

SEMESTER- I & II

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week) and Credits				Scheme of Evaluation (Marks)					
			L	T	P	Cr	Theory			TW	PR/ VV	Total
							CT	TA	ESE			
SEMESTER- I												
1	GE-52001	Research Methodology	2	-	-	2	20	20	60	-	-	100
2	CE-52001	Computational and Statistical Methods	3	-	-	3	20	20	60	-	-	100
3	CE-52002	Advanced Soil Engineering	3	-	-	3	20	20	60	-	-	100
4	CE-52003	Geotechnical Lab – I	-	-	4	2	-	-	-	25	25	50
Total of Semester-I			**8**	**-**	**4**	**10**	**60**	**60**	**180**	**25**	**25**	**350**
SEMESTER-II												
1	CE-52004 to CE-52006	*Program Elective-I	3	-	-	3	20	20	60	-	-	100
2	CE-52007 to CE -52009	** Program Elective -II	3	-	-	3	20	20	60	-	-	100
3	CE-52010	Advanced Foundation Engineering	3	-	-	3	20	20	60	-	-	100
4	SW-52001 to SW-52007	Audit Course	2	-	-	-						
5	CE-52011	Geotechnical Lab – II	-	-	4	2	-	-	-	25	25	50
Total of Semester-II			**11**	**-**	**4**	**11**	**60**	**60**	**180**	**25**	**25**	**350**

- **A minimum of 6 students and maximum of 12 students can register for the course.**

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* Program Elective - I
1) CE-52004: Soil Dynamics and Machine Foundations
2) CE-52005: Ground Water Engineering
3) CE-52006: Offshore Geotechnical Engineering

** Program Elective- II
1) CE 52007: Geology For Geotechnical Applications
2) CE-52008: Environmental Geotechnology
3) CE-52009: Reinforced Earth Structures

List of Audit Courses:
1. SW52001- English for Research Paper Writing
2. SW52002- Sanskrit for Techincal Knowledge
3. SW52003- Value Eduction
4. SW52004- Constitution of India
5. SW52005- Pedagogy Studies
6. SW52006- Stress Management by Yoga
7. SW52007- Personality Developent through Life Enlightenment Skills.

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SEMESTER-III & IV

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week) and Credits				Scheme of Evaluation (Marks)					
			L	T	P	Cr	Theory			TW	PR/ VV	Total
							CT	TA	ESE			
SEMESTER- III												
1	CE-52012	Ground Improvement Techniques	3	-	-	3	20	20	60	-	-	100
2	CE-52013 to CE-52015	^ Program Elective -III	3	-	-	3	20	20	60	-	-	100
3	CE-52016	Geotechnical Lab – III	-	-	4	2	-	-	-	25	25	50
Total of Semester-III			**6**	**-**	**4**	**8**	**40**	**40**	**120**	**25**	**25**	**250**
SEMESTER-IV												
1	CE-52017 to CE-52019	$ Program Elective -IV	3	-	-	3	20	20	60	-	-	100
2	CE-52020 to CE-52022	~ Program Elective –V	3	-	-	3	20	20	60	-	-	100
3	CE-52023	Geotechnical Lab – IV	-	-	4	2	-	-	-	25	25	50
4	CE-52024	Mini Project with Seminar	-	-	4	2	-	-	-	50	50	100
TOTAL SEMESTER-IV			**6**	**-**	**8**	**10**	**40**	**40**	**120**	**75**	**75**	**350**

- **A minimum of 4 students should register for the course.**

^ Program Elective- III

1) CE-52013: Soil Structure Interaction
2) CE-52014: Geotechnical Earthquake Engineering
3) CE-52015: Pavement Analysis and Design

$ Program Elective- IV

1) CE -52017: Geotechnics for Design of Underground Structures
2) CE -52018: Geotechnical Centrifuge Modeling
3) CE- 52019: Finite Element Methods

~ Program Elective- V

1) CE 52020: Project Planning and Mangement
2) CE-52021: Economics and Finance for Engineers
3) CE-52022: Intellectual Property Management

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SEMESTER-V & VI

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week) and Credits				Scheme of Evaluation (Marks)					
			L	T	P	Cr	Theory			TW	PR/ VV	Total
							CT	TA	ESE			
SEMESTER- V												
1	CE-62025	#Open Elective	3	-	-	3	20	20	60	-	-	100
1	CE-62026	Dissertation-I	-	-	20	10	-	-	-	50	50	100
TOTAL OF SEMESTER-V			**3**	**-**	**20**	**13**	**20**	**20**	**60**	**50**	**50**	**200**

Note: Students going for Industrial Project/Dissertation will coplete these courses through MOOCs, NPTEL, SWAYAM etc.

SEMESTER-VI

Sr. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week) and Credits				Scheme of Evaluation (Marks)					
			L	T	P	Cr	Theory			TW	PR/ VV	Total
							CT	TA	ESE			
2	CE-62027	Dissertation-II	-	-	32	16				100	150	250
TOTAL OF THIRD YEAR			**-**	**-**	**32**	**16**				**100**	**150**	**250**
GRAND TOTAL			**34**	**-**	**72**	**68**	**220**	**220**	**660**	**300**	**350**	**1750**

#Open Electives

1) CE-62025: Environment Impact Assessment and Green Building.

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(CBCS-AICTE Model-2018-19 Onwards)

Detailed Syllabi of All Courses

SEMESTER - I

GE 52001: Research Methodology

(CBCS -AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	2Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**2**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the prospective researchers to basic methodologies and techniques of carrying out research work. The course provides detailed knowledge of developing a research plan and research design. Various statistical methods are included in this course which will be needed for a research work. Along with this, optimization techniques, modeling and simulation and soft computing techniques required for solution of a research problem are included in the course. At the end, Interpretation of result and technique of report writing will be taught to the students.

Course Outcomes:

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

1. Develop a research plan and define the research problem
2. Analyze the data required for research
3. Solve the mathematical model developed with the help of optimization techniques
4. Apply the knowledge to write a research paper and dissertation scientifically

Detailed Syllabus:

Unit -1:	**Introduction and Research Process:** Objectives of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem, Selecting the Problem, Technique Involved in Defining a Problem, Research Design, Important Concepts Relating to Research Design, Developing a Research Plan, Literature review.	**8 Hrs**
Unit -2:	**Statistics:** Basic Concepts of Probability, Probability Axioms, Measures of Central Tendency, Measures of Dispersions, Measures of	**8 Hrs**

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	Symmetry, Measures of Peakedness. Regression Analysis – Simple Linear Regression, Multiple linear Regression, Correlation. Tests of Hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, students't' distribution: properties, application with example. Chi-square distribution: definition, constants of Chi-square distribution. Application with example. F-test: example of application.	
Unit -3:	**Optimization Techniques:** Linear Programming, Simplex Method, Dual Simplex, Sensitivity Analysis. Artificial Variable Technique, Dynamic Programming, Introductory concepts of non-linear programming. **Or** **Modeling and simulation:** Introduction to modeling: Concept of system, continuous and discrete systems. Experimental Methods: Importance of experimental analysis, guidelines for designing experiments, uncertainty and error analysis, concept of uncertainty, propagation of uncertainty, planning experiments from Uncertainty analysis.	**8 Hrs**
Unit -4:	**Soft Computing:** Fuzzy logic: Introduction, Concepts, Basic Fuzzy Mathematical Operations, Fuzzy databases, Membership Functions, Fuzzy Linear Programming, And Neural Networks: Artificial Neural Networks, architectures and algorithms, Basic neuron models, Neural network models, Learning algorithms, Genetic Algorithms: Introduction to genetic algorithm, Operators, Applications.	**8 Hrs**
Unit -5:	**Interpretation and Report Writing:** Meaning of Interpretation, Techniques of Interpretation, Significance of Report Writing, Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Writing a technical paper, plagiarism and its implications.	**8 Hrs**

References:

1. Gupta. S.P., " Statistical Methods", S. Chand & Sons, New Delhi
2. Kothari C.R., "Research Methodology-Methods and Techniques", New Age International Publishers, New Delhi.
3. Gupta S.L. and Gupta Hitesh, "Research Methodology-Text and cases with SPSS applications" International Book House Pvt. Ltd., New Delhi.
5. Rao V and Rao H., "C++, Neural Networks and Fuzzy Logic", BPB Publications, New Delhi.
6. Goldberg, D.E., "Genetic Algorithms in Search, Optimization & Machine Learning", Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, Delhi.
7. Klir George J. and Yuan Bo, "Fuzzy Sets and Fuzzy Logic", PHI Learning Pvt. Ltd, New Delhi

CE52001: Computational and Statistical Methods

(CBCS - AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial		Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the engineering Computational and Statistical Methods such as Taylor's Series, Euler's Method, Runge Kutta Method. Regression Analysis, Correlation and Regression Analysis. Skewness, Moments and Kurtosis Which is widely required to solve engineering problem. Fuzzy and genetic algorithm its application.

Course Outcomes:

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

1) Identity information about statistical analysis, probability and soft computing skills.
2) Execute problems related to water resources engineering.
3) Judge and compare the solution of a field problem.
4) Use in data analysis for the dissertation.

Detailed Syllabus:

Unit -1:	Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series, Euler's Method, Runge Kutta Method, Newton Raphson Method, Bisection Method. Gauss-Jordan Method, Method of Leading Coefficient. Relaxation Method	**8 Hrs**
Unit -2:	Regression Analysis : Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypothesis – Multiple linear Regression – Correlation and Regression Analysis. Skewness, Moments and Kurtosis	**8 Hrs**
Unit -3:	Classification and Presentation of data, Basic Concepts of Probability, Probability Axioms, Analysis and Treatment of Data, Population and Samples, Measures of Dispersions, Measures of Symmetry Discrete and Continuous Probability Distribution Functions	**8 Hrs**
Unit -4:	Finite difference methods and its applications to water resources Engineering. Introduction to FEM and its applications to water resources Engineering	**8 Hrs**
Unit -5:	Fuzzy logic, Fuzzy Mathematical Operations, Neural Networks, Mathematical Model of Neuron, Architecture. Introduction to genetic algorithm, Operators, Applications.	**8 Hrs**

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References:

1. Gupta, S. P. (1999). "Statistical Methods", S. Chand & Sons
2. Haan C. T., (1995), "Statistical Methods in Hydrology", East West Press, New Delhi
3. Sastry, S. S. (1995), "Introductory Methods of Numerical Analysis", Prentice Hall of India (p) Ltd., New Delhi
4. Krishnaraju and Muthu, Numerical Methods for Engineering Problems, Second Edition,MacMillan India Ltd, Delhi
5. Rao V and H. Rao, (1996) "$C^{++,}$ Neural Networks and Fuzzy Logic, BPB Publications, New Delhi.
6. Goldberg, D. E. (2000), "Genetic Algorithms in Search, Optimization & Machine
7. Learning", Addison Wesley Longman (Singapore) Pvt. Ltd., Indian Branch, Delhi.

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CE 52002: Advanced Soil Engineering

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course focuses on study of soil properties and classification of soils, calculation of stresses, shear strength, and earth pressure, identification of expansive soils

Course Outcomes:

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

1. interpret soil properties and classify the soils.
2. carry out calculations of stresses, shear strength, and earth pressure.
3. analyze the stability of slopes.
4. identify expansive soils and modification of expansive soil.

Detailed Syllabus:

Unit -1:	Introduction to soil engineering, Civil engineering problems related to soils, Complexity of soil nature, Soil formation and soil types, Regional soil deposits of India, Soil as a multiphase material, Important relationships, Consistency of clays, Soil aggregate properties, Applications of soil classification.	**8 Hrs**
Unit -2:	Soil structure and fabric, Clay minerals, Structure and engineering behavior of compacted soils, Elastic methods of stress distribution in soils, Approximate stress distribution methods for loaded areas, Shear strength behavior of sand and clays, Drainage conditions and strength parameters. Soil sampling and degree of disturbance.	**8 Hrs**
Unit -3:	Steady state flow, Seepage, Laplace equation, Flow nets, Prevention of erosion, Compressibility and consolidation, Three dimensional consolidation, Settlement computations and analysis, Compression index, Empirical correlations, Sand drains	**8 Hrs**
Unit -4:	Stability of slopes, Limiting equilibrium method and critical stages in stability, Total and effective stress method of analysis, Use of stability coefficients, Effect of earthquake force-Pseudo static analysis, Earth pressure theories, Design considerations for retaining walls,	**8 Hrs**
Unit -5:	Drainage, De-watering and Wells, Design of dewatering system, Adverse effects of drainage, Identification of expansive soils, Parameters, Classification, Moisture changes, Effects of swelling, Preventive measures and modification of expansive soil, Liquefaction, Rheology.	**8 Hrs**

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References:

1. Joseph E. Bowels, "Physical and Geotechnical Properties of Soil", Tata Mc. Graw-Hill.
2. Braja M. Das, "Advanced Soil Mechanics", Tata Mc. Graw-Hill.
3. R.F. Scot, "Principles of Soil Mechanics", Addison and Wesley.
4. Gopal Ranjan and A. S. R. Rao, "Basic and Applied Soil Mechanics", New Age International Publishers.
5. Gulhati S. K. and Manoj Datta, "Geotechnical engineering", Tata Mc. Graw-Hill.

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52003: Geotechnical Lab – I

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs./Week	Term Work	25 Marks
Practical	4 Hrs./Week	Viva-voce	25 Marks
Total Credits	2		
		Total	50 Marks

Prerequisite: Not applicable

Course Description: This course covers principles, applications and performance of experiments.

Course Outcome: After the successful completion of the course student will be able to:

1. Execute experiments for determination of index properties of soil.
2. Determine engineering properties of soil.
3. Classify the soil.

Detailed Experiment List:

I-A report of the experimental work based on any six of the following :

1. I.S. classification of soil;
2. Consistency limits;
3. Determination of field density of soil;
4. Determination of coefficient of permeability ;
5. Compaction test;
6. Tests to measure the shear strength of soil;
7. Tests to measure parameters of expansive soil.

II- Writing assignments for any two Soil engineering problems, such as Lateral earth pressure, Stress distribution, Seepage, model analysis (design experiment) Candidates are required to submit the duly completed journals before the end of semester.

Practical Examination shall consist of term work assessment and viva-voce.

References :

1. J. E. Bowles, "Physical and Geotechnical Properties of soils", McGraw Hill International publication.
2. T.W. Lambe, "Soil Testing for Engineers", Wiley Publication.
3. Compendium of Indian Standards on Soil Engineering, SP-36 (Part-1).

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***Program Elective - I CE 52004: Soil Dynamics and Machine Foundations**

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Course Description: This courses includes basics of dynamics, dynamic behaviour of soils, effects of dynamic loads and the various design methods for machine foundation.

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

1. design foundation for different machines,
2. assess the influence of vibrations and selection of remediation methods based on the nature of vibration, properties and behaviour of soil.
3. methods of reducing vibration in existing foundation.
4. suggest remedial measures for earthquakes in existing earthen and gravity dam.

Detailed Syllabus:

Unit-1:	Theory of Vibration- degree of freedom system, Vibration absorber, Vibration Isolation, Spectral Response, Wave Propagation- theory and its applications, Transient and vibratory loading, Strengths and deformation characteristics of soils under dynamic loads.	**8 Hrs.**
Unit-2:	Dynamic Earth pressure- retaining walls under dynamic loading, Analytical and graphical methods. Shallow footings- Bearing capacity under dynamic loads designs	**8 Hrs.**
Unit-3:	Pile foundation- Behaviour of piles under dynamic loads, Machine foundations, Special features, resonant frequency, Behaviour and design of Machine Foundation, Methods of reducing vibration in existing foundation.	**8 Hrs.**
Unit-4:	Hammer Foundations, Limiting design of hammer foundation, Dynamic compaction of soils, Various theories of compaction, Methods of compaction, case histories	**8 Hrs.**
Unit-5:	Earth dams- design criterion, Model testing and Analysis, Case histories of failure of earthen and gravity dam due to earthquake, Remedial measures for earthquakes in existing earthen and gravity dam.	**8 Hrs.**

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References:

1. S. Prakash, "Soil Dynamics", McGrawhills book company
2. B.M. Das, "Fundamentals of Soil Dynamics", Elsevier Publications
3. S. Prakash and V.K. Puri, "Foundation for Machine: Analysis and Design", John Wiley and sons
4. F.E, Richart, J.R. Hall and R.D. Woods, "Vibration of Soil and Foundation", Prentice-Hal Inc., New Jersey
5. IS: 5249-1969/1975, :Method of Test for determination of In situ dynamic properties of Soils

Approved in XIXth Academic Council, dated 27/07/2018

* Program Elective I CE 52005: Ground Water Engineering

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Course Description: This course introduces different aspects of ground water engineering, determination of permeability and transmissibility by Theim and Dupuit's theory. It also evaluates aquifer properties for confined aquifer by Theis method, Jacob and Chow's method. Topics ranges from construction of well, water well design, drilling, components of ground water, ground water flow and ground water development and management.

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

1. Demonstrate the different terminologies related with groundwater hydrology
2. Identify suitable method of determination of aquifer parameters
3. Choose suitable ground water exploration techniques and assess ground water potential
4. Compare and contrast suitable ground water development and management methods

Detailed Syllabus:

Unit-1:	**Ground Water:** porosity, retention of water in rocks, yield of rock, compressibility of rock, zone of aeration and saturation, fluctuation of water table and piezometric surfaces, storage coefficients of aquifers, specific yield, specific retention, unconfined and confined aquifer, ground water potential in India, geophysical methods for groundwater explorations.	**8 Hrs.**
Unit-2:	**Ground water flow:** Laminar and turbulent flow, Darcy's law, Reynolds number, permeability and transmissibility, Groundwater flow potential, Ground water theory for one, two and three dimensional problem, Differential equations governing groundwater flow for steady and unsteady state problems, Theim and Dupuit's theory for unconfined and confined aquifers, use of finite difference method to solve simple ground water flow problem.	**8 Hrs.**
Unit-3:	**Evaluation of Aquifer Properties:** aquifer tests, control well, observation well, Solution of aquifer parameters for confined aquifer by Theis method, Jacob and Chow's method, Theis' recovery method, bounded aquifer, interference among wells, aquifer properties for bounded aquifers by theory of images.	**8 Hrs.**

Unit-4:	**Construction of Wells and Ground Water Modeling:** types of wells and method of construction, tube well design and well drilling: well screen, development and completion of wells, well performance test, well loss, Rotary drilling and Rotary percussion drilling, maintenance of wells. Groundwater Modeling: Groundwater flow, sand models, membrane model, thermal model, electric analog model and mathematical models.	**8 Hrs.**
Unit-5:	**Groundwater Recharge, Development and Management:** Components of ground water balance, estimation of recharge component, ground water storage changes, conjunctive use, artificial recharge of groundwater- different methods, subsurface dam, recharge by urban storm runoff, percolation from tanks, recharge from irrigated fields, groundwater quality, estimation of ground water discharge, ground water resource evaluation in India.	**8 Hrs.**

References:

1. Todd, D.K. "Ground Water Hydrology", John Wiley & Sons, Singapore.
2. Raghunath, H.M. "Ground Water" New Age International (P) Limited, New Delhi.
3. Karanth, K. R. "Ground Water Assessment Development and Management", Tata McGraw
   Hill Publishing Company Limited, New Delhi
4. Domenico "Concepts and Models in Groundwater Hydrology", McGraw Hill Inc., NewYork
5. L. Harvil and F. G. Bell, *Ground Water Resources and Development*, Butterworth's, London.
6. Herbert F Wang and Mary P. Anderson "Introduction to Ground Water Modeling", W.H. Freeman and Company, NewYork

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*Program Elective I CE 52006: Offshore Geotechnical Engineering

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course covers basics of marine soil behaviour, design of offshore foundations, seabed anchors, and submarine pipelines.

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

1. understand offshore site investigations: sampling and sampling disturbance
2. know insitu testing, wireline technology
3. stability of submarine slopes. Installation and stability of submarine pipelines.
4. offshore pile foundations for jacket type structures.

Detailed Syllabus:

Unit -1:	Submarine soils: Origin, nature and distribution. Terrigenic and pelagic soils. Submarine soils of India.	**8 Hrs**
Unit -2:	Engineering behaviour of submarine soils: under-consolidated soils, calcareous soils, cemented soils, corals.	**8 Hrs**
Unit -3:	Offshore site investigations: sampling and sampling disturbance, insitu testing, wireline technology. Offshore pile foundations for jacket type structures.	**8 Hrs**
Unit -4:	Foundations of gravity structures; Foundations for jackup rigs. Anchors and breakout forces; anchor systems for floating structures.	**8 Hrs**
Unit -5:	Stability of submarine slopes. Installation and stability of submarine pipelines.	**8 Hrs**

References

1. E.T. Richard Dean. Offshore Geotechnical Engineering, ICE, UK, London, 2009.
2. Mark Randolph and Susan Gourvenec. Offshore Geotechnical Engineering, CRC Press, 2011.
3. H. G. Poulos. Marine Geotechnics, Unwin Hyman, 1988.
4. Susan Gourvenec and Mark Cassidy. Frontiers in Offshore Geotechnics,Taylor & Francis, 2005.
5. William O. McCarron. Deepwater Foundations and Pipeline Geomechanics, J. Ross

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** Program Elective II CE 52007: Geology For Geotechnical Applications

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course provides the knowledge and skills in assessing the quality of foundation rocks, their aggregates and building materials derived from rock and assess the geological suitability of sites.

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

1. assess the suitability of a construction site and the construction materials with respect to the geological parameters.
2. do engineering classification of rocks
3. apply Logging techniques
4. suggest geological solution for slope stability in landslides areas

Detailed Syllabus:

Unit -1:	Engineering Properties of Rocks And Minerals : Geology for foundation engineering – Types of rocks, rock description-texture, structure, composition and its relation to quality and strength of rocks, engineering classification of rocks –weathering grade and its significance in engineering site-Engineering properties of rocks - Physical and chemical properties of minerals and its relation to strength and durability of rock. Geotechnical properties of rocks of Maharashtra.	**8 Hrs**
Unit -2:	Surface And Subsurface Geological Investigations : Field investigations - electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering, applications of GPR in subsurface strata studies, Description of structural discontinues, Strike and dip of rocks, folds, faults and joints.	**8 Hrs**
Unit -3:	Drill Hole And Core Logging : Logging techniques – Resistivity log, Neutron log, sonic log, gamma log. Rock core logging – rocks description, weathering grade, RMR, RQD and sampling methods for rock strength, and composition studies.	**8 Hrs**
Unit -4:	Mapping Techniques : Preparation of profiles from contour map; lithological and structural mapping of shallow and deep excavated sites. Hand on exercises.	**8 Hrs**
Unit -5:	Geological Investigations For Foundation Engineering :Ground stability studies - Scour and erosion studies-stability of slopes and geological solution for slope stability in landslides areas.	

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REFERENCES:

1. Varghese P.C. Engineering Geology for civil engineers, PHI learning Pvt.Ltd. New Delhi-1, 2012
2. Krynine and Judd Principles of Engineering Geology and Geotechnology McGraw Hill, New York 1962.
3. Bell FG. by Engineering Geology, Second Edition, Butterworth-Heinemann, Oxford, 2007
4. Sathya Narayanaswami, Engineering Geology, Dhanpat Raj and Co.1710, Nai Sarak, Delhi-110 006, 2000.
5. Waltham, A.C. Foundations of Engineering Geology, Blackie Academic Professional Pub.1 Ed.UK.1994
6. Venkata Reddy. D., Engineering geology, Vikas Publishing Home, Noida, 2010
7. Chenna Kesavulu. N., Text book of engineering geology, II edition, MacMillan Publishers India Ltd. Delhi, 2009.

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** Program Elective II CE 52008: Environmental Geotechnology

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course includes the geotechnical aspects of the design and management of industrial and domestic waste disposal systems.

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

1. characterization and regulatory requirements for disposal of hazardous, nonhazardous and domestic waste
2. sources and effects of subsurface contamination
3. do waste management
4. plan and design aspects related to waste disposal in landfills

Detailed Syllabus:

Unit -1:	Identification, Characterization and regulatory requirements for disposal of hazardous, nonhazardous and domestic waste Sources and effects of subsurface contamination, Physical, Chemical and biological characteristics of solid waste, Soil-waste interaction, Cation exchange reactions and effect of pollutants on soil properties, Erodability of soil in relation to moisture content, Containment transport, Laboratory and field evaluation of permeability, Factors affecting, Design of dewatering.	**8 Hrs**
Unit -2:	Waste management – Recycling, Composting, Incineration, and various disposal Sources and effects of subsurface contamination l methods, Site Selection, Leachet collection and detection system Types of landfills – Silting criteria, Waste containment principle, Types of barrier materials.	**8 Hrs**
Unit -3:	Planning and design aspects relating to waste disposal in landfills Landfills – Ash ponds and Tailing ponds and in rocks, Environmental monitoring around landfills – Detection, Control and remediation of subsurface containment.	**8 Hrs**
Unit -4:	Engineering properties and Geotechnical reuse of waste, Demolition of waste .	**8 Hrs**
Unit -5:	Reclamation of old waste dumps, Regulation, Case studies Single and double lined landfill, Applications of Geosynthetics in waste disposal design, Landfill construction, Construction quality control and performance monitoring.	**8 Hrs**

References:

1. Geotechnical Practices for Waste Disposal, D.E Daniel, Chapman and Hall, London,
2. Geo-environmental Engineering Principles and Application, L.N. Reddy and H.F. Inyang, Marceal Dekker Inc.,
3. Introduction to Environmental Geotechnology, Hsai-Yang Fang, CRC Press ,
4. Geotechnical and Geoenvironmental Engineering Handbook, R. K Rowe, Klower Academic Publishers,
5. Waste Containment Systems, Waist stabilization and Landfills, Design and Evaluation, H. D. Sharma and S. P. Lewis, John Willey and Sons,
6. Geoenvironmental Engineering, H. D. Sharma and K. R. Reddy, John Willey and Sons,
7. Geoenvironemntal Engineering, R N Yong and H R Thomas, Thomas Telford,

** Program Elective II CE 52009: Reinforced Earth Structures

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course introduces different earth reinforcing materials.

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

1. suggest use of different reinforcing materials as per field conditions
2. gaining knowledge of different types geosynthetics
3. design with geosynthetics
4. designing for roadway reinforcement

Detailed Syllabus:

Unit -1:	Reinforced soil- mechanism, reinforcement, reinforcement- soil interaction, applications, reinforced soil structures with vertical faces, reinforced soil embankments, open excavation using soil nails, stabilization of slopes using soil nails.	**8 Hrs**
Unit -2:	Geosynthetics - types- Geotextiles, Geogrids, Geonets, Geomembranes, Geosynthetic clay liners, Geopipe, Geocomposite, Geo-others, Polymeric material: Brief overview, polymer identification- manufacture and current uses of Geosynthetics materials.	**8 Hrs**
Unit -3:	Designing with Geotextiles : Design methods - design by cost and availability, Design by specification, Design by function, Geotextiles functions and mechanisms- separation, reinforcement, filtration, drainage, liquid barrier and combined functions	**8 Hrs**
Unit -4:	Designing with Geogrids and Geonets: Geogrid properties and test methods, physical properties, mechanical properties, degradation properties, allowable strength consideration, Designing for geogrid reinforcement-paved roads, unpaved roads, embankments, design critique, Construction methods using geogrids, Geonet-properties and test methods, physical and mechanical properties, hydraulic properties, environmental properties, designing for geonet drainage, design critique, construction methods using geonets.	**8 Hrs**
Unit -5:	Designing for roadway reinforcement-unpaved roads, overview, manufacturer's methods, analytic method, laboratory method, designing for soil reinforcements- Geotextile reinforced walls, construction details, and design methods.	**8 Hrs**

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References:

1. Robert M. Koerner - "Designing with Geosynthetics" Prentice Hall, Upper Saddle River, New Jersey 07458
2. Proceedings of various Inter-national and national conferences on geosynthetics
3. Geotextiles and Geomembranes, Journal of International Geosynthetics Society, Elsevier Publication
4. Shashi Gulathi and Manoj Datta "Geotechnical Engineering", Tata McGraw-Hill Publishing Company Limited, New Delhi

Approved in XIXth Academic Council, dated 27/07/2018

CE 52010: Advanced Foundation Engineering

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Basic knowledge of Geotechnical Engineering and Applied mechanics
Course Description: This course introduces different site investigation methods, Types of foundations, loading conditions and suitability

Course Outcomes:

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

1. Suggest and prepare plan to be adopted for exploration of soil depending on field conditions
2. Design of foundation under different loading conditions
3. Evaluate bearing capacity for varied site conditions
4. Select methodologies to be adopted for foundations on expansive soil

Detailed Syllabus:

Unit -1:	Soil Site investigations: Methods of exploration, Methods of boring, Soil samples, Number and disposition of trial pits and borings, Depth of exploration, Ground water observations, Field Tests, Geophysical methods, Borehole logs, Site investigation report.	**08 -- Hrs**
Unit -2:	Shallow foundations: Types of foundations, Location and depth of foundation, Bearing capacity of shallow foundations, Bearing capacity from building codes, Effect of water table on bearing capacity, Proportioning of footings. Settlement of shallow foundations, Loading conditions.	**08 -- Hrs**
Unit -3:	Pile foundation: Introduction, Uses of piles, Classification of piles, Selection of pile type, Pile driving, Pile capacity, Pile groups, Negative skin friction, Load test on piles, Static pile load formulae, Dynamic pile formulae, Laterally loaded piles, Batter piles.	**08 -- Hrs**
Unit -4:	Cofferdams, Caissons: Cofferdams uses and features, Types of caissons, Components of a well foundation, Shapes of wells, Forces acting on well foundation, Construction and sinking of a well, Rectification of tilts and shifts.	**08 -- Hrs**
Unit -5:	Foundations on expansive and collapsible soils: Parameters of expansive soil, Identification of expansive soils, Free swell test, Differential free swell test, Swelling pressure tests, Field conditions that favor swelling, Effects of swelling on a structure, Foundation techniques	**08 -- Hrs**

References:

1. V.N.S.Murthy, "Soil mechanics and foundation engineering"Vol.1, Saikrupa Technical Consultants, Bangalore.
2. J.E.Bowles, Foundation analysis and design, McGraw Hill International, New York.
3. Wayne C. Teng, "Foundation Design" Prentice Hall of India, New Delhi.
4. K.R. Arora, "Soil Mechanics and Foundation Engineering" Standard Publishers Distributors.
5. Shashi K. Gulhati and Manoj Datta, "Geotechnical Engineering"Tata McGraw Hill Publication, Latest edition.
6. T.W. Lambe, Soil Testing for Engineers, John Wiley Publication.
7. Gopal Ranjan,A.S.R.Rao, " Basic and Applied Soil Mechanics", New Age International Publishers, New Delhi.
8. Relevant Indian Standard Specifications and Codes.

CE52011: Geotechnical Lab – II

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs./Week	Term Work	25 Marks
Practical	4 Hrs./Week	Viva-voce	25 Marks
Total Credits	**2**		
		Total	50 Marks

Prerequisite: Not applicable

Course Objectives: In Geotechnical Lab – II Students will be performing or see demonstrations of field tests

Course Outcome: After the successful completion of the course student will be able to:

1. perform different Field tests.
2. interpret test results and suggest the suitability of foundation.
3. use available/ educational software for the analysis of soil engineering problems.

I - A report of the experimental work or demonstration of the following(any five) :

1. Large direct shear test;
2. Tri-axial test;
3. Consolidation test;
4. Plate load test;
5. Standard Penetration test.
6. Field visit to study geotechnical aspects.

II - Solving problems on calculation of Stresses, Shear Strength, Bearing capacity, Earth pressures, Load calculation for different types of foundations or
Use of available / educational software for the analysis of Soil engineering problems.

Practical Examination shall consist of term work assessment and viva-voce.

Reference Books :

1. J. E. Bowles, "Physical and Geotechnical Properties of soils", McGraw Hill International publication.
2. T.W. Lambe, "Soil Testing for Engineers", Wiley Publication.
3. Compendium of Indian Standards on Soil Engineering, SP-36 (Part-1 &2).

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CE 52012: Ground Improvement Techniques

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs./Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE 3004

Course Description: This course exposes the students to basic methodologies and techniques of ground improvement techniques. The course provides detailed knowledge on stabilization of soil and its methods.

Course Outcomes:

After successful completion of the course, students will:

1. Gain the concepts behind a range of ground improvement and soil remediation techniques.
2. Be able to explain different ground improvement method.
3. Be able to analyze and suggest techniques for ground improvement.
4. Be able to apply the knowledge to solve field problems related to ground improvement.

Detailed Syllabus:

UNIT-1	Clay mineralogy - Atomic bonds, Clay minerals. Clay-water relations, Electrical effects, cation exchange, Clay mineral identification, Classification of stabilizing agents and stabilizing process. Nature and surface characteristics of soil particles. Concepts of surface area and contact points. Necessity of soil Stabilization.	**8 Hrs**
UNIT-2	Soil stabilization – Principle, Different methods of soil stabilization Chemical stabilization - Principle, Different methods, Different chemicals used, Engineering, properties and behavior of chemically stabilized soils. Cement stabilization - Types, Mechanism, Properties, Factors influencing, Applications, Laboratory testing for stabilized soil, Lime stabilization - Soil-lime reaction, Types and properties, Effectiveness of lime treatment, Mixture design, Ash and slag stabilization - Fly-ash stabilization, Bituminous stabilization - Classification, mechanism, Laboratory testing, Thermal and electro kinetic stabilization – Thermal, Heating and freezing, Electro-osmosis, Construction methods for stabilized soils.	**8 Hrs**
UNIT-3	Deep Compaction of Granular soil – Introduction, Vibration methods– Vibro-flotation, Vibro compaction, Blasting, Displacement methods.Stone-gravel and sand column, Design of stone columns, Compaction piles, Dynamic Consolidation, Preloading method.	**8 Hrs**

UNIT-4	Grouting in soils, different methods of grouting- Permanent grouting, displacement soil fracture grouting, displacement compaction grouting, jet or replacement-displacement grouting, grouted columns. Reinforced soil, Reinforcement-soil interaction, Reinforced soil structure with vertical faces, Reinforced soil with embankments.	**8 Hrs**
UNIT-5	Stabilization of slopes using soil nails, reinforcement of soil beneath foundations. Geosynthetics, Necessity of its use, Types of Geosynthetics, Function of Geosynthetics, Properties of Geosynthetics, Functional requirements, Designing with Geosynthetics.	**8 Hrs**

REFERENCE BOOKS

1. M. R. Hausmann, Engineering Principles of ground Modifications, McGraw-Hill International Edition, 1990.
2. M. P. Moseley, Ground Improvement, Blackie Academics and Professionals, 1993
3. P. P. Xanthakos, L. W. Abramson and D. A. Bruce, Ground Improvement and Control, John Wiley & Sons, 1994.
4. R. H. Manfired, Engineering Principles of Ground Modifications, McGraw-Hill, 1990.
5. Dr. P Purushothama Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi, First Edition, 1999.
6. S. K Gulati and Manoj Datta, Geotechnical Engineering, Tata McGraw Hills Publications, New Delhi, Third Reprint, 2007

^Program Elective III CE- 52013: Soil Structure Interaction

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Course Description: In this course focus is on idealization of soil response to closely represent continuum behavior and interaction analysis between the soil-structure with reference to relative stiffness of beams, slabs and piles under different loading conditions.

Course Outcomes:

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

1. explain concept of nature and complexities of soil structure interaction.
2. determine the pile capacities for different loading.
3. carry out linear and non-linear analysis.
4. solve structural interaction problems under earthquake loading.

Detailed Syllabus:

Unit -1:	**Soil Response Interaction Analysis:** Soil–foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, soil-foundation interaction analysis, soil response models, Elastic continuum, Winkler model.	**08 Hrs**
Unit -2:	**Soil Structure Interaction:** Interaction problems based on theory of sub grade reaction on beams, footings, rafts.	**08 Hrs**
Unit -3:	**Analysis of Pile and Pile Groups:** Determination of pile capacities and negative skin friction, group action of piles, Anchor piles, laterally loaded piles and pullout resistance, well foundation	**08 Hrs**
Unit -4:	**Linear and Non-Linear Analysis:** Analysis of different types of frame structure founded on stratified natural deposits with linear and non-linear stress-strain characteristics.	**08 Hrs**
Unit -5:	**Engineering Applications of Dynamic Soil-Structure Interaction:** Low rise residential buildings, multistory buildings, bridges, dams, nuclear power plants, offshore structures, soil-pile-structure interactions.	**08 Hrs**

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References:

1. Bowels J.E.," Analytical and Computer Methods in Foundation", McGraw HillBook Co. New York, Latest Edition.
2. Desai C.S. and Christian J.T. "Numerical Methods in GeotechnicalEngineering" McGraw Hill Book Co. NewYork, Latest Edition.
3. Soil Structure Interaction, The real behavior of structures, Institution of StructuralEngineers, Latest Edition.
4. Elastic Analysis of Soil Foundation Interaction, Developments inGeotechnical Engg.vol-17, Elsevier Scientific PublishingCo., Latest Edition.
5. Selvadurai A.P.S. "Elastic Analysis of Soil-Foundation Interaction", Elsevier Scientific PublishingCompany, Latest Edition.
6. Swami Saran " Analysis & Design of substructures", Oxford& IB Publishing Co. Pvt.Ltd., Latest Edition.
7. Kurian Nainan P. "Design of Foundation System- Principles & Practices", Narosa PublishingHouse, Latest Edition.
8. Salgado, R., "The Engineering of Foundations", Tata McGraw Hill Education Private Limited, New Delhi, Latest Edition.
9. Saran, S, "Analysis and Design of Substructures", Taylor & Francis Publishers, Latest Edition.

^Program Elective III CE- 52014: Geotechnical Earthquake Engineering

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: In this course focus is on seismic hazards, seismology, strong ground motion measurement, seismographs, ground response analysis, seismic slope stability.

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

1. get aware about Earthquake Engineering aspects Geotechnical Engineering.
2. analyze ground Response Analysis.
3. design Retaining Walls by Considering Seismic effects.
4. estimate ground parameters.

Detailed Syllabus:

Unit -1:	Introduction, Seismic Hazards, Seismology, Internal Structure of Earth, Seismic Waves, Plate Tectonics, Plate Boundaries, Elastic Rebound Theory, Earthquake Intensity, Earthquake Magnitude and Energy.	**8 Hrs**
Unit -2:	Strong ground Motion Measurement, Seismographs, Strong Motion Processing, Strong Motion Records Ground Motion Parameters, Estimation of Ground Parameters.	**8 Hrs**
Unit -3:	Wave Propagation Waves in Unbounded Media, One Dimensional and Three Dimensional Wave Propagation, Waves in a Semi Infinite Body, Waves in a Layered body, Attenuation of Stress Waves, Measurement of Dynamic Soil Properties, Stress-Strain Behavior and Strength of Cyclically Loaded Soils.	**8 Hrs**
Unit -4:	Ground Response Analysis, One, Two and Three Dimensional Ground Response Analysis, Local site Conditions on Ground Motions, Design Parameters, Liquefaction, Evaluation of Liquefaction Hazards and Liquefaction Susceptibility, Effects of Liquefaction.	**8 Hrs**
Unit -5:	Seismic Slope Stability, Earthquake Induced Landslides and Activity, Evaluations of Slope Stability, Static and Seismic Slope Stability Analysis, Seismic Design of Retaining Walls, Types of Retaining Walls, Static Pressures on Retaining Walls, Seismic Pressures of Retaining Walls, Seismic Displacements of Retaining Walls, Seismic Design Consideration.	**8 Hrs**

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REFERENCES:

1. Wright, P.H., Highway Engineers, John Wiley & Sons, Inc., New York, 1996.
2. Khanna S.K and Justo C.E.G, Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee, 2001.
3. Yoder R.J and Witchak M.W., Principles of Pavement Design, John Wiley, 2000.
4. Croney, D., Design and Performance of Road Pavements, HMO Stationary Office, 1979.
5. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
6. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
7. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.
8. O' Flaherty, C.A., Highways – The location, Design, Construction & Maintenance of Pavements, Fourth Edition, Elsevier, 2006.
9. Bell. P.S., Developments in Highway Engineering, Applied Sciences publishers

CE52016: Geotechnical Lab – III

(CBCS-AICTE Model)

Scheme of Teaching		Scheme of Evaluation	
Practical	4 Hrs/Week	Term Work	25 Marks
		Viva Voce examination	25 Marks
Total Credits	**2**	**Total**	**50Marks**

Prerequisites: Not Applicable

Course Description: The course provides the fundamentals of the use of geotechnical software's for analysis and design of geotechnical structural elements using geotechnical engineering software like, Plaxis, Geo-slopes, Finite Element Software, Educational software related Geotechnical Engineering etc.

Course Outcomes:

After the completion of the course, the students will be able to:

1. To recognize the different facilities available in application software's for analysis and design of geotechnical structures
2. To analyze and design various types of components in geotechnical structures using the software's.
3. To analyze and design various types of components in footing element structures using the software's.
4. To model, analyze and design simple structures using geotechnical engineering software's.

Detailed Syllabus

UNIT-1 Introduction to application of software's in geotechnical engineering: Plaxis/ Geo-slopes/ Finite Element Software etc with simple examples	06 Hrs
UNIT-2 Analyze and design various types of components in geotechnical elements such as footing, caisson and slope using the software's.	06 Hrs
UNIT-3 Analysis and design of geotechnical engineering elements	06 Hrs

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Term Work:

The term work shall consist of numerical examples on analysis and design of various geotechnical elements. Analysis and designed by using various software's such as Plaxis/ Geo-slopes/ Finite Element Software etc. The candidate shall prepare a journal in a prescribed format.

Viva Voce Examination: Based on the term work submitted by the student, a Viva-voce examination shall be conducted by the panel of examiners. The panel of examiner consists of a course coordinator as an internal examiner and the external examiner appointed by the controller of examination.

$ Program Elective IV CE- 52017: Geotechnics for Design of Underground Structures (CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: This course highlights to visualize and critically analyze the behaviour of underground structures with reference to various supporting systems under different loading conditions due to induced earth pressure on the underground structures.

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

1. analyze and design the underground structures with reference to various supporting systems that needs for underground construction
2. develop the understanding to protect the adjacent building due to underground construction
3. gain knowledge of anti-water insulation of underground structures
4. design of ground anchors

Detailed Syllabus:

Unit -1:	Ground Movements And Its Effects : Building response to ground movements, concept of limiting tensile strain, strains in simple rectangular beams, ground movement due to tunneling and excavation, lateral supporting systems, retaining walls, factors influencing on the selection of the retaining system, case history.	**8 Hrs**
Unit -2:	Analysis Of Underground Supporting Systems : free and fixed earth support method, shear failure of strutted walls, push in, basal heave, upheaval, sand boiling, Stress and deformation analysis of excavation: simplified method, beam on elastic foundation method , finite element method.	**8 Hrs**
Unit -3:	Design Of Underground Supporting Systems : principles of retaining wall design, types of wall support systems, design of structural elements, Permanent situations, bottom-up/top-down construction sequences, Props, Tied systems, Soil berms, Design of ground anchors, resistance to vertical and lateral actions	**8 Hrs**
Unit -4:	Design Of Tunnel : longitudinal and transverse profile of tunnel structure, protection against fire, advanced systems of anti-water insulation of underground structures, loading types of shallow and deep tunnels, rock mass classification, mining technologies of deep excavation, shield technology, execution technology of shallow underground structures, sewerage objects, trenchless technologies.	**8 Hrs**
Unit -5:	Protection Of Adjacent Buildings : behavior of excavation and tunneling induced deformation, building protection by auxiliary methods – construction defects and remedial measures – building rectification methods.	**8 Hrs**

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REFERENCES:

1. Deep Excavation Theory and Practice by Chang – Yu Ou, Taylor & Francis Group, London, UK, 2006.
2. An Introduction to Geotechnical Engineering by Holtz, R.D. and Kovaces, W.D., Prentice – Hall, Inc., Englewood Cliffs, NJ, 1981.
3. Soil Mechanics in Engineering Practice by Terzaghi, K. and Peck, R. B, John Wiley & Sons, New York, 1967.
4. Foundation Engineering by Peck, R. B., Hanson, W.E., and Thornburn, T.H., John Wiley & Sons, New York, 1977.
5. Engineering Principles of Ground Modification by Hausman, M. R., McGraw – Hill Publishing Company, New York, 1990.

$ Program Elective IV CE- 52018: Geotechnical Centrifuge Modelling
(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: To study Concepts, types and applications in Centrifuge modelling

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

1. understand various types of modelling techniques such as physical and numerical, for solving the problems of geotechnical engineering.
2. understand the concept of centrifuge modelling
3. understand the application of dimensional analysis in centrifuge modelling , similarity laws and scale effects.
4. understand the utility of the centrifuge modelling techniques for solving geotechnical problems related to static, dynamic, seepage and consolidation cases.

Detailed Syllabus:

Unit -1:	Modelling, Physical and numerical modelling, Types of physical modelling: 1-g and N-g modelling,	**8 Hrs**
Unit -2:	Concept of centrifuge modelling,	**8 Hrs**
Unit -3:	Application of dimensional analysis in centrifuge modelling, application of centrifuge modelling for static and dynamic geotechnical problems,	**8 Hrs**
Unit -4:	Similarity laws, scale effect,	**8 Hrs**
Unit -5:	Seepage and consolidation problems, case studies	**8 Hrs**

References:

1. R. N. Taylor, "Geotechnical centrifuge technology" Blackie Academic and Professional-an imprint of Chapman and Hall, UK (1995)
2. Gopal Madabhushi,"Centrifuge Modelling for Civil Engineers",CRC press

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$ Program Elective IV CE- 52019: Finite Element Methods
(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	3	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not required.

Course Description: This course offers a numerical method good for solving complex structural problems based on finite element method.

Course Outcomes:

After successful completion of the course, students will be able:

1. To identify soil behavior of various types of finite elements used in analysis of geotechnical problems.
2. To analyze typical geotechnical engineering problems using basic mathematical methods relevant to finite element analysis of geotechnical problems.
3. To define and use various isoparametric finite elements. To compute error estimates in finite element analysis of geotechnical problems.
4. To apply appropriate modeling considerations for solving various geotechnical problems.

Detailed Syllabus:

Unit -1:	Introduction to Finite Element Analysis Introduction to finite element method, Types of finite elements, Properties of various finite elements.	**08 Hrs**
Unit -2:	Basic Equation from Solid Mechanics, Isoparametric element and interface elements. Constitutive models for soils, Techniques for nonlinear analysis.	**08 Hrs**
Unit -3:	Applications of FEMs to various soil engineering problems. Boundary Element Methods in Geomechanics.	**08 Hrs**
Unit -4:	Error Estimation and Convergence: Sources of error, ill-conditioning, discretization error, convergence rate, mesh revision methods.	**08 Hrs**
Unit -5:	Modeling Considerations: Physical behavior verses element behavior, element shapes and interconnection, material properties, loads and reactions, connections in structures, boundary conditions, stress concentrations.	**08 Hrs**

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References:

1. ChandrupatlaT R and BelegunduA D, Introduction to finite elements in engineering, 3rd edition, Pearson Prentice Hall, India, Latest Edition.
2. ReddyJ N, An introduction to the finite element method, 3rd edition, Tata McGraw Hill, India, Latest Edition.
3. DesaiY M, EldhoT I and ShahA H, Finite element method with applications in engineering, Pearson, Delhi, Latest Edition.
4. Olgierd C. Zienkiewicz, R. L. Taylor, The Finite Element Method: Basic Formulation and Linear Problems, Volume 1, McGraw-Hill College, Latest Edition.
5. Desai / Abel, Introduction to Finite Element Method, Paperback, Latest edition.

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~ Program Elective V CE- 52020: Project Planning and Management

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3Hrs/Week	Class Test	20Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	**100 Marks**

Pre-requisites: Not Applicable

Course Objectives: The objective of the course to know the students basics of project management and planning.

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

1. Understand basics of project planning
2. Apply management methodology, monitoring and control techniques.
3. Understand environmental dimensions of a project and stresses on environment.
4. Understand project management , process management and project organization
5. Know Progress, Performance and Risk Measurement

Detailed Syllabus:

Unit -1:	**The Basics of Project Planning** Introduction, What is Project Planning?, Why do we need project planning?, Elements of project plan, . Project Scope Planning, Triangular Constraints (TQR), Delivery Schedule Planning, Project Resources Planning, Project Cost Planning, Project Quality Planning, . Supporting Plans- Risk Management Plan, Communication Plan, Procurement Plan,	**06 Hrs**
Unit -2:	**Project Management Methodology, Monitoring &Control** Management methodology, Control and Risk, Balancing the Control System, Progress Reporting System, Five Types of Status Reports, Variances, How & When To Collect Data?, How and What Information to Update, Displaying Status, Charting the Work Break down Structure(WBS) to Report Project Status	**06 Hrs**
Unit -3:	**Environmental Appraisal of Projects** Objective , Introduction, Types and Environmental Dimensions of a Project , Stresses on Environment, Environmental Impact Assessment Methodologies	**06 Hrs**

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Unit -4:	**Project *Management.* & Project Organization** Introduction, project management and process management, Project organization and responsibilities, Organisational models, Choosing the project organization, Developing a project network plan, Time Calculations.	**06 Hrs**
Unit -5:	**Progress, Performance and Risk Measurement** Introduction, The project control process, Performance Indicators, Project monitoring ,Evaluation, and Control, Risk management and Risk Identification, Risk Analysis, Risk Response and Risk control.	**06 Hrs**

Teacher's Assessment: Teachers Assessment of 20 marks may be based on one or more of the following

1) Technical quizzes
2) Application development
3) Question & answer / Numerical solution
4) Group discussion
5) Other if any

References: .

1) Prasana Chandra: Projects-Planning Analysis, Selection, Implementation & Review, Tata McGraw Hill, New Delhi.
2) M.Shaghil and M. Mushtaque : Project Planning and Management Vol. 1
3) C. Choudhury : Project Management, Tata McGraw Hill, New Delhi – 1995
4) Desai, Vasant: Project Management
5) P. Gopala Krishnan and V. Rama Moorthy : Project Management

~ Program Elective V CE- 52021: Economics and Finance for Engineers (CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not Applicable

Course Description : For any construction project to be successful, it must be technically sound and the resulting benefits must exceed the cost associated with the project. This course "Economics and Finance for Engineers" basically aims at describing various aspects of engineering economics. The field of construction economics and finance deals with the systematic evaluation of cost and benefit associated with different projects. The topics in this course cover principles of engineering economy followed by basic methods for carrying out economic studies considering the time value of money. The other topics include the demonstration of different methods namely present, future and annual worth method, rate of return, break-even comparison, capitalized-cost and cost-benefit analysis for the comparison of alternatives. In addition, other topics those will be covered are different methods of depreciation, taxes, and cost analysis of construction equipments followed by cost estimating. Further, topics on financial management namely construction accounting, financial statements, financial ratios and working capital management are also included in this course. The topics will be developed in a logical sequence. For clear illustration of concepts, a number of problems will be solved. This course will definitely help the students and teachers in understanding the underlying principles and concepts in economics and finance

Course Outcomes:

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

1) Fundamental understanding of the concepts of Economics, namely Micro and Macro Economics.
2) Apply the Basic concepts of principle Cash flow using various Interest calculation Formulae
3) Understanding of Project planning with a specific view on project Financing.
4) Know decision making techniques based on financial guidelines.
5) Understanding how projects are framed and planned and executed

Approved in XIXth Academic Council, dated 27/07/2018

Detailed Syllabus:

Unit -1:	**Engineering Economics** Basic principles – Time value of money, Quantifying alternatives for decision making, Cash flow diagrams,Equivalence- Single payment in the future (P/F, F/P), Present payment compared to uniform series payments (P/A,A/P), Future payment compared to uniform series payments (F/A,A/F),Arithmetic gradient, Geometric gradient.	**06 Hrs**
Unit -2:	**Comparison of Alternatives** Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-cost analysis.	**06 Hrs**
Unit -3:	**Depreciation and Replacement Analysis** Depreciation - methods and calculation, Inflation, Taxes, Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis	**06 Hrs**
Unit -4:	**Cost Estimating** Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes, Parametric estimate, Life cycle cost.	**06 Hrs**
Unit -5:	**Financial Management:** Construction accounting, Chart of Accounts, Financial statements – Profit and loss, Balance sheets, Financial ratios, Working capital management.	**06 Hrs**

Teacher's Assessment: Teachers Assessment of 20 marks may be based on one or more of the following

1) Technical quizzes
2) Application development
3) Question & answer / Numerical solution
4) Group discussion
5) Other if any

REFERENCES:

1. Blank, L. T. and Tarquin,A. J.,"Engineering Economy", Fourth Edition, WCB/McGraw-Hill, 1998.
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8. Newnan, D. G.,Eschenbach, T. G. and Lavelle, J.P.,"Engineering Economic Analysis", Indian Edition, Oxford University Press, 2010.
9. Ostwald,P. F.,"Construction CostAnalysis and Estimating",Prentice Hall, Upper Saddle River, New Jersey, 2001.
10. Peterson,S. J.,"Construction Accounting and Financial Management",Pearson Education, Upper Saddle River, New Jersey, 2005.
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12. Peurifoy, R. L. and Oberlender, G. D.,"Estimating Construction Costs", 5th ed., McGrawHill, New Delhi, 2004.
13. Schexnayder, C. J. and Mayo, R.E.,"Construction Management Fundamentals", International Edition, McGraw-Hill, 2003.
14. Sullivan, W. G.,Bontadelli, J.A. and Wicks,E. M.,"Engineering Economy", 11th ed., Prentice Hall, Upper Saddle River, New Jersey, 2001.

~CE 52022: Program Elective V: Intellectual Property management

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20 Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The course introduces and provides a critical survey of the new field of commons in intellectual property, and gives students the opportunity to pursue more detailed study of a topic of interest to them. And provide a superior environment to the employees and students of the Institute for creation, protection, and commercialization of intellectual property and to stimulate innovation. Also it increases research, scholarship, and a spirit of inquiry, thereby generating new knowledge. Intellectual Property (IP) Policy 130 Research Programme Regulations. So that transfer of knowledge and technology should be easy to intending users to promote utilization of such resources for benefit of the society.

Course Outcomes: After successful completion of the course student will able to:

1) Have an advanced and integrated understanding of the complex body of knowledge in the field of Indian intellectual property law, including the international context and:

2) know the requirements that need to be satisfied to establish entitlement to the grant of intellectual property rights in both jurisdictions

3) understand the procedures by which grant of intellectual property rights are obtained

4) understand the requirements that need to be satisfied to establish infringement of those right

Detailed Syllabus:

Unit -1:	Fundamentals and general introduction to the concept and philosophy of IPR – Evolution and relevance of IPR in global and Indian scenario – Different types of IPR	**8 Hrs**
Unit -2:	Law of patents – Industrial designs – geographical indications – confidential information – right to secrecy – patent infringement – abuse of patent rights – duration of patents – compulsory licensing	**8 Hrs**
Unit -3:	monitoring of patent obligations and practice – remedies against patent infringement – national and international perspectives –	**8 Hrs**
Unit -4:	conventions and tactics on patent – dispute resolution – patent	**8 Hrs**
Unit -5:	Indian IP policy - Definition of Consultancy - Importance and scope of industrial consultancy - case studies	**8 Hrs**

References:

1. Intellectual property, cases and materials – W.R. Cornish
2. Law relating to intellectual property rights – Ahuja V.K.
3. Law of trademarks, copyrights, patents – Salil K. Roy Chaudhary
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007

Approved in XIXth Academic Council, dated 27/07/2018

5. Intellectual Property in New, Robert P. Merges, Peter S. Menell, Mark A. Lemley,

CE52024: Geotechnical Lab – IV

(CBCS-AICTE Model)

Model Testing

Scheme of Teaching		Scheme of Evaluation	
Practical	4 Hrs/Week	Term Work	25
Total Credits	**2**	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: Not Applicable
Course Description: This is a Lab course in to get an experience of testing of geotechnical structural elements.

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

1. Plan a testing scheme
2. Carryout scaled model testing of geotechnical members/systems
3. Examine the behavior of structural members like different footing, slopes etc., under applied loading
4. Interpret the test results and compare with analytical results and draw inferences

Detailed Syllabus:
At least test two of the following structural members in two batches

1. Column footing
2. Slopes
3. Raft
4. Pile
5. Well foundation
6. Caisson.

Term Work:
The term work shall consist of a comprehensive journal consisting of records of testing as detailed under the syllabus above.

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CE-52024: Mini Project with Seminar

(CBCS AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	0 Hrs/Week	Term Work	50Marks
Tutorial/Practicals	4 Hrs/Week	Viva-voce	50 Marks
Total Credits	**2**		
		Total	100 Marks

Prerequisite: Not applicable

Course Description: The student shall collect, review, compile, comprehend, present research literature and identify the problem for the dissertation in the field of geotechnical engineering.

Course Outcomes:

After successful completion of the course, students will be able:

1. To search literature from different sources to appraise the state-of-the-art.
2. To compile and prepare a technical report from the collected literature.
3. To present the literature in a comprehensive manner.
4. To identify the problem for the dissertation

Term Work:

The Mini Project with Seminar shall consist of collection of literature from a chosen field of geotechnical engineering from various sources such as refereed journals, proceedings of national international conferences, PG/PhD theses etc. Based on the literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary the candidate shall define the problem for the dissertation.

The candidate shall prepare a technical report in a prescribed format and present before a panel of examiners consisting of guide and at least one faculty member of the department.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 10 Marks: A mid-term evaluations for 10 marks out of 25 marks shall be done as per the schedule given in the institute academic calendar. Student should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and one faculty members appointed by the DCoE as external examiners. The panel of examiner will assess the contents and presentation and give the suggestions, if any and assigns the marks out of 10. In this phase student is expected to collect and present substantial literature.

Part-II: End Semester Evaluation for 15 Marks: Student should prepare technical report in prescribed format duly incorporating suggestions of Part-I and present power point presentation before the panel of examiners and class students. The student should be able to answer the questions asked. The panel of examiner will assess the seminar contents and seminar presentation and assigns the marks out of 15. In this phase the students is expected to

define the problem for dissertation through further literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary.

#Open Elective-V:CE-62025: Environment Impact Assessment and Green Building

(CBCS-AICTE Model)

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test	20Marks
Tutorial	-	Teacher's Assessment	20 Marks
Total Credits	**3**	End Semester Examination	60 Marks
		Total	**100 Marks**

Prerequisite: Not required

Course Description: The course contains environment impact assessment, environment management plan, conducting environmental audit and information about green building.

Course Outcome: After successful completion of the course, student will able to,

1. Assess environment impact.
2. Prepare environment management plan.
3. Prepare environmental audit.
4. Plan, analyze and design green building.

Detail Syllabus:

Unit -1:	General : Global and Indian Scenario,National Environmental Policy	**06 Hrs**
Unit -2:	Environmental Organizations for planning and implementation Sustainable Development	**06 Hrs**
Unit -3:	Preventive and reactive strategies for environmental pollution control.Environmental impact and risk assessment.Methodology :Adhoc, Checklist, Network, Matrix etc.	**06 Hrs**
Unit -4:	Environmental Management plan, Typical Case Studies of Environmental Impact Assessment, Environmental impact statements Environmental Audit.Environmental Legislation, Air, Water and Environmental Acts.	**06 Hrs**
Unit -5:	Introduction to Green Buildings, Site Selection & Planning, Water Conservation, Energy Efficiency, Building Materials & Resources, Indoor Environmental Quality, Innovation and Development, Green	**06 Hrs**

	Building Case Study.	

Teacher's Assessment: Teachers Assessment of 20 marks may be based on one or more of the following

1) Technical quizzes
2) Application development
3) Question & answer / Numerical solution
4) Group discussion
5) Other if any

REFERENCES:

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2. S. Musharaf, Legal aspects of Environmental Pollution and its management, C.B.S. Publishers, Delhi, Latest Edition.
3. Jain R. K., L.V. Urban, B. S. Staccy, H.E. Balkbach, Environmental Assessment, McGraw Hill Inc, NY, Latest Edition.
4. Rao, J. G. and Wooten, Environmental Impact Analysis, Handbook 1980.Center, L.W. Environmental Impact Assessment, New York: McGraw Hill Book Company, Latest Edition.
5. Book on Green building

SEMESTER-VI

CE-62026: Dissertation-I

(CBCS-AICTE Model)

Scheme of Teaching		Scheme of Evaluation	
Dissertation-	20 Hrs/Week	Term Work	50 Marks
Total Credits	**10**	Viva Voce	50 Marks
		Total	**100Marks**

Prerequisites: Not applicable.

Course Description:

The Dissertation work is one of the important aspects of PG education incorporating the research component in the curriculum. The student is required to study the existing literature from various sources such as refereed journals, proceedings of National/International conferences, PG , PhD theses reference book etc. of geotechnical Engineering. The student would identify the problem and provide solution/s through experimental/Analytical/comparative study as partial fulfillment of PG degree.

The dissertation-I mainly focuses on literature survey, identification of problem and action plan with possible outcomes for the completion of Dissertation-II

Course Outcomes: After successful completion of the course, students will be able:

1. To appraise the state-of-the-art in the chosen field through exhaustive literature survey.
2. To formulate/define the problem for dissertation
3. To compile and prepare a technical report of the collected literature and present.

Term Work:

The Dissertation-I shall consist of collection of literature from a chosen field of geotechnical engineering from various sources. The candidate shall formulate/define analytical and/or experimental problem for carrying out dissertation work. The candidate shall prepare a technical report in a prescribed format. The evaluation of the term work shall be through submission of monthly progress report of the student in prescribed format.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 25 Marks: A mid-term evaluations for 25 marks out of 50 marks shall be done as per the schedule given in the institute academic calendar. Students should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and at least one

faculty member appointed by the Head of the Department as external examiner. The panel of examiner will assess the contents and presentation and gives the suggestions, if any and assigns the marks out of 25marks.

Part-II: End Semester Evaluation for 25 Marks: Students shall prepare a comprehensive report incorporating the suggestions of part-I, if any and make a power point presentation before the panel of examiners as above and class students and should be able to answer questions asked by the panel of examiners and class students. The panel of examiner will assess the contents and presentation and assigns the marks out of 25 marks.

SEMESTER-VI

CE62027: Dissertation-II

(CBCS-AICTE Model)

Scheme of Teaching		Scheme of Evaluation	
Practical	32 Hrs/Week	Term Work	100 Marks
Total Credits	16	Viva Voce	150 Marks
		Total	250 Marks

Prerequisites: Students should have completed CE62026: Dissertation-I satisfactorily.

Course Description:

The dissertation-II is a continuation of Dissertation-I and mainly focuses on solution of the defined problem through experimental/analytical/comparative study as planned.

Course Outcomes: After successful completion of the course, students will be able:

1. To appraise the additional literature in the chosen field of geotechnical engineering.
2. To refine the formulated problem in the chosen field of geotechnical engineering.
3. To find solution to the identified problem using appropriate methodology.
4. To interpret, discuss, debate the solution and draw conclusions.
5. To write the thesis and present before panel of examiner and peers.

Term Work:

The Dissertation-II shall consist of a complete analytical and/or experimental work in geotechnical engineering containing literature survey, problem formulation, solution, results, interpretations, discussions and conclusions certified by guide and an internal evaluation committee. The candidate shall prepare a technical report in a prescribed format and submit soft bound 3-hard copies signed by the guide and submit it to the CoE for viva-voce examination. After the viva-voce examination, student shall submit 3-hard bound copies after the corrections, if any, suggested by the panel of examiners along with program exit survey in prescribed format. The evaluation of the term work shall be based on monthly progress report of the student in prescribed format and final submission.

Paper Publications:

A proof of uploading paper to SCI, Web of Science, Scopus, Indian Citation Index journal or filling patent is mandatory requirement for submission of dissertation. However, if the dissertation work is in collaboration with industry/organization/research agency, the uploading of paper/filling a patent shall not be mandatory but desirable.

Pre submission presentation:

There shall be a pre submission presentation before a panel of experts/faculty consisting of guide and faculty/experts and all PG students of the concerned class.

Viva Voce Examination:

Students should prepare a power point presentation and present it before the panel of examiners consisting of guide and the external examiner appointed by the CoE. The candidate should be able to defend his work in front of the panel of examiners and class students. The panel of examiners will assess the dissertation contents and presentation and assigns the marks out of 150.

Table 1 Mapping of Course outcome with Program Outcomes