M.E. (Full Time)   **Prospectus No. 151740**

संत गाडगे बाबा अमरावती विद्यापीठ
SANT GADGE BABA AMRAVATI UNIVERSITY

अभ्यासक्रमिका
(FACULTY OF ENGINEERING & TECHNOLOGY)

PROSPECTUS

Prescribed for
Post Graduate Degree Course
Master of Engineering
(Full Time)

I & IInd Year Examinations 2014 - 2015 & Onwards
Semester Pattern
Credit Grade System

BRANCH

1) M.E. Civil (Geotechnical Engineering(Full Time)

2015

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SANT GADGE BABA AMRAVATI UNIVERSITY

SPECIAL NOTE FOR INFORMATION OF THE STUDENTS

(1) Notwithstanding anything to the contrary, it is notified for general information and guidance of all concerned that a person, who has passed the qualifying examination and is eligible for admission only to the corresponding next higher examination as an ex-student or an external candidate, shall be examined in accordance with the syllabus of such next higher examination in force at the time of such examination in such subjects papers or combination of papers in which students from University Departments or Colleges are to be examined by the University.

(2) Be it known to all the students desirous to take examination/s for which this prospectus has been prescribed should, if found necessary for any other information regarding examinations etc., refer the University Ordinance Booklet the various conditions/provisions pertaining to examination as prescribed in the following Ordinances.

Ordinance No. 1	:	Enrolment of Students.
Ordinance No. 2	:	Admission of Students
Ordinance No. 4	:	National cadet corps
Ordinance No. 6	:	Examinations in General (relevent extracts)
Ordinance No. 18/2001	:	An Ordinance to provide grace marks for passing in a Head of passing and Inprovement of Division (Higher Class) and getting Distinction in the subject and condonation of defficiency of marks in a subject in all the faculties prescribed by the Statute No.18, Ordinance 2001.
Ordinance No. 9	:	Conduct of Examinations (relevent extracts)
Ordinance No. 10	:	Providing for Exemptions and Compartments
Ordinance No. 19	:	Admission of Candidates to Degrees.

Ordinance No. 109	:	Recording of a change of name of a University student in the records of the University.
Ordinance No. 6 of 2008	:	For improvement of Division/Grade.
Ordinance No.19/2001	:	An Ordinance for Central Assessment Programme, Scheme of Evaluation and Moderation of answerbooks and preparation of results of the examinations, conducted by the University, Ordinance 2001.

Dineshkumar Joshi
Registrar
Sant Gadge Baba Amravati University

PATTERN OF QUESTION PAPER ON THE UNIT SYSTEM

The pattern of question paper as per unit system will be broadly based on the following pattern.

(1) Syllabus has been divided into units equal to the number of question to be answered in the paper. On each unit there will be a question either a long answer type or a short answer type.

(2) Number of question will be in accordance with the unit prescribed in the syllabi for each paper i.e. there will be one question on each unit.

(3) For every question long answer type or short answer type there will be an alternative choice from the same unit. However, there will be no internal choice in a question.

(4) Division of marks between long answer and short answer type question will be in the ratio of 40 and 60.

(5) Each short answer type question shall Contain 4 to 8 short sub question with no internal choice.

SANT GADGE BABA AMRAVATI UNIVERSITY
DIRECTION

No. 31/2010   Date : 24 /6/2010

Subject :   Examinations leading to the Degree of अभियांत्रिकी पारंगत (Master of Engineering) (Full-Time) / तंत्रशास्त्र पारंगत (Master of Technology) (Full Time) (Semester Pattern .... Credit Grade System)

Whereas the schemes of teaching & examinations of Master of Engineering (Full-Time) / Master of Technology (Full Time) courses has been accepted by the Academic Council vide Item No. 49 in its meeting held on 28-05-2010 as per the Credit Grade System for its implementation from the Academic Session 2010-2011,

AND

Whereas admissions to the First Year of Master of Engineering (Fullt-Time) / Master of Technology (Full Time) courses are to be made in the Academic Session 2010-2011,

AND

Whereas the matter for admission of the students at the examinations is required to be regulated by an Ordinance,

AND

Whereas the schemes of teaching & examinations of I and II Semesters of Master of Engineering (Full-Time) / Master of Technology (Full Time) courses are to be implemented from the academic session 2010-2011,

AND

Whereas the schemes of teaching & examinations are required to be regulated by the Regulation,

AND

Whereas the process of making an Ordinance and the Regulation is likely to take some time,

AND

Whereas syllabus for I and II Semesters of Master of Engineering (Full-Time) / Master of Technology (Full Time) courses are to be sent for printing.

Now, therefore, I, Dr.Ku.Kamal Singh, Vice-Chancellor of Sant Gadge Baba Amravati University in exercise of powers confirmed upon me under sub section (8) of Section 14 of the

Maharashtra Universities Act, 1994, hereby direct as under :

1.   This Direction may be called "Examinations leading to the Degree of अभियांत्रिकी पारंगत (Master of Engineering) (Full-Time) / तंत्रशास्त्र पारंगत (Master of Technology) (Full Time) (Semester Pattern .... Credit Grade System) Direction, 2010.

2.   This Direction shall come into force w.e.f. the session :-
      i)   2010-2011 for First Year, and
      ii)   2011-2012 for Second Year

3.   Following shall be the Examinations leading to the Degree of Master of Engineering (Full Time)/ Master of Technology (Full Time) courses :-
      i)   M.E./M.Tech. Semester-I Examination
      ii)   M.E./M.Tech. Semester-II Examination
      iii)   M.E./M.Tech. Semester-III Examination
      iv)   M.E./M.Tech. Semester-IV Examination

3.

4.   Examinations of IIIrd & IVth semesters shall be held at the end of IVth semester seperately.

5.   An applicant for admission to the Degree of Master of Engineering (Full Time) / Master of Technology(Full-Time) courses shall have passed the Degree Examination in Bachelor of Engineering/Bachelor of Technology in the branches mentioned under column No.2 of the following table against respective course :-

TABLE

M.E./M.Tech. other statutory University	B.E./B.Tech. of this University or any
1.	2.
a) M.E. Civil (Structural Engg.)	Civil /Construction Engg., Water Management
b) M.E. Mechanical (CAD/CAM)	Mechanical/Automobile/Production/ Industrial Engineering
c) M.E. Digital Electronics	Electronics & Telecommunication, Electronics Engg., Industrial Electronics, Instrumentation & Information Tech.
d) M.E. Electrical (E.P.S.)	Electrical / Electrical Power System / Electronics & Power
e) M.Tech. Chemical Technology (Membrane & Separation Technology)	Chemical Engineering/Chemical Technology

f) M.Tech. (Chemical Engineering)	Chemical Engg./Chemical Tech., Petrochemical Engg./Tech., Plastics & Polymer Engg./Tech., Pulp & Paper Tech.	
g) M.E. (Computer Science & Engineering)	Computer Science & Engineering, Computer Technology, Computer Engineering, Electronics Engg., Electronics & Telecommunication, Information Technology	
h) M.E. (Information Technology)	Information Technology, Computer Science & Engineering, Computer Technology, Computer Engineering, Electronics & Telecommunication, Electronics Engineering	
i) M.E. (Electronics & Telecommunication)	Electronics & Telecommunication, Electronics Engg., Industrial Electronics & Instrumentation	

6. The Degree of Master of Engineering (Full-Time) / Master of Technology (Full-Time) shall be awarded to an examinee who in accordance qualifies in any one of the following subjects :-
   1) M.E. Civil (Structural Engineering)
   2) M.E. Mechanical (CAD/CAM)
   3) M.E. Digital Electronics
   4) M.E. Electrical (Electrical Power System)
   5) M.Tech. Chemical Technology (Membrane & Separation Technology)
   6) M.Tech. Chemical Engineering
   7) M.E. Computer Science & Engineering
   8) M.E. Information Technology
   9) M.E. Electronics & Telecommunication Engineering

7. (i) University shall hold Main Examinations of Semester-I of above mentioned Full Time Degree Courses in Winter every year and Supplementary Examinations in Summer every year at the end of the Second Semester
   (ii) University shall hold Main Examinations of Semesters-II, III & IV in Summer every year and Supplementary Examinations in Winter every year.
   (iii) The period of Academic session shall be such as may be notified in Academic Calender of the concerned academic session.

   (iv) Examinations shall be held at such places and on such dates as may be notified by Board of Examinations.

8. For the purposes of Instructions and Examinations, students shall study sequentially.

9. Subject to his/her compliance with the provisions of Ordinance relating to Examinations in General, the applicant for admission to an examination at the end of the course of study of a particular semester shall be eligible to appear at it, if;
   (i) He/She has satisfied the conditions mentioned in the following table and the provisions thereunder.

TABLE I

Sr. No.	Name of Exam.	The student should have completed the term satisfactorily of	The student should have passed the subjects of examination of
1.	M.E./M.Tech. Semester-I	Semester-I	----
2.	M.E./M.Tech. Semester-II	Semester-II	----
3.	M.E./M.Tech. Semester-III	Semester-III	2/3 heads of passing of Semester- I & II taken together
4.	M.E./M.Tech. Semester-IV	Semester-IV	----

(Explanation :- The Theory or Practical part of the subject shall be treated as separate head of Passing.)
   (ii) He/She shall not be allowed to submit the dissertation till he/she has passed in all subjects of I & II Semester.

10. The schemes of teaching & examinations shall be as provided under "Appendices A, B, C, D, E, F, G, H and I" appended with this Direction.

11. The fees for each M.E. (Full Time) / M.Tech. (Full Time) Examinations (Theory & Practical) shall be as prescribed by University from time to time.

12. The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of an examinee shall be as given below :-
   The marks will be given in all examinations which will include college assessment marks and the total marks for each Theory / Practical shall be converted into Grades as per Table II.

SGPA shall be calculated based on Grade Points corresponding to Grade as given in Table II and the Credits allotted to respective Theory / Practical shown in the scheme for respective semester.

SGPA shall be computed for I, II and IV Semester (**III & IV Semester together**) and CGPA shall be computed in IV semester based on SGPAs of I, II and IV Semester. :-

$$SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + ... + C_n \times G_n}{C_1 + C_2 + ... + C_n}$$

Where C_1 = Credit of individual Theory / Practial
G_1 = Corresponding Grade Point obtained in the respective Theory / Practical

$$\frac{CGPA}{X(Cr)_{IV}} = \frac{(SGPA)_I \times (Cr)_I + (SGPA)_{II} \times (Cr)_{II} + (SGPA)_{IV}}{(Cr)_I + (Cr)_{II} + (Cr)_{IV}}$$

Where $(SGPA)_{I, II, IV}$ = SGPA of I, II & IV Semester
$(Cr)_{I, II, IV}$ = Total Credits for I, II & IV Semester

TABLE II
THEORY & PRACTICALS

Grade	Percentage of Marks	Grade Points
AA	85 £ Marks £ 100	10
AB	75 £ Marks < 85	9
BB	70 £ Marks < 75	8
BC	65 £ Marks < 70	7
CC	60 £ Marks < 65	6
CD	55 £ Marks < 60	5
DD	50 £ Marks < 55	4
FF	00 £ Marks < 50	0
ZZ	Absent in Examination	--

13. (i) The scope of the subject shall be as indicated in the syllabus.
    (ii) The medium of instructions and examination shall be English.
14. Provisions of Ordinance No.18 of 2001 in respect of an Ordinance to provide grace marks for passing in a Head of passing and improvement of Division (Higher Class) and getting distinction in the subject and condonation of deficiency of marks

in a subject in all the faculties prescribed by the Statute No.18, Ordinance, 2001 shall apply to each examination under this Direction.

15. An examinee, who does not pass or who fails to present himself/ herself for the examination, shall be eligible for readmission to the said examination on payment of fresh fees, and such other fees as may be prescribed by the University.

16. As soon as possible after the examination, the Board of Examinations shall publish a result of the examinees. The result of all examinations shall be classified as above and branchwise merit list shall be notified as provided under Original Ordinance No.6.

17. Notwithstanding anything to the contrary, no one shall be admitted to an examination, if he/she has already passed the said examination or an equivalent examination of any Statutory University.

18. (i) Examinees who have passed in all the subjects prescribed for all the examinations of the particular branch shall be eligible for award of the Degree of Master of Engineering/ Master of Technology in that branch including specilization.
    (ii) The Degree Certificate in the prescribed form shall be signed by the Vice-Chancellor.

Sd/-
(Dr. Kamal Singh)
Vice-Chancellor

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DIRECTION

No. 22 / 2014   Dated :- 28/08/2014

Subject :-Corrigendum to Direction No. 31 of 2010 in respect of the Examinations leading to the Degree of अभियांत्रिकी पारंगत (Master of Engineering) (Full Time) तंत्रशास्त्र पारंगत (Master of Technology) (Semester Pattern . . . Credit Grade System)

Whereas, the Direction No.31/2010 in respect of the examinations leading to the degree of अभियांत्रिकी पारंगत (Master of Engineering) (Full Time) तंत्रशास्त्र पारंगत (Master of Technology) (Full Time) (Semester Pattern - - -Credit Grade System) is in existence in the University,

AND

Whereas, the schemes of teaching and examinations for various branches of Two Year Post Graduate Degree Course in Master of Engineering (Full Time) in the Faculty of Engineering & Technology have been provided vide appendices A B,C,D,E,F,G,H & I appended with Direction No. 31 of 2010,

AND

Whereas, the provision for the admission and other details to the Degree of Master of Engineering (Full Time) are prescribed in the Direction No. 31 of 2010,

AND

Whereas, the Direction Nos. 30/2012 and 32/2012 which were issued as Corrigendum to Direction No. 31 of 2010 for revised schemes of teaching & examinations of M.E. Civil (Structural Engineering) (Full Time), M.E. Civil (Transportation Engg.), M.E.Mechanical (Thermal Engg.), M.E.Mechanical (Adv.Manufacturing & Mechanical Systems Design) and M.E.(Computer Science & Information Technology) are in existence,

AND

Whereas, College of Engineering, Ghatkhed, Mardi Road, Amravati has obtained approval from the Government for starting new course i.e. M.E.Civil (Geotechnical Engineering) (Full Time) (C.G.S.) from the current academic session 2014-2015,

AND

Whereas, Sant Gadge Baba Amravati University has granted first time affiliation for the above mentioned course to College of Engineering, Ghatkhed, Mardi Road, Amravati from the session 2014-2015,

AND

Whereas, the Board of Studies in Civil Engineering (Incl.Construction Technology) in its meeting held on 17th July & 5th August, 2014 has resolved to accept and recommend to the Faculty and Academic Council the scheme of teaching & examination, draft syllabus alongwith Eligibility Criteria for its implementation from the current academic session 2014-2015 and onwards,

AND

Whereas, Hon'ble Vice Chancellor has accepted the Scheme of teaching & examination alongwith Eligibility Criteria of the above mentioned course under Section 14 (7) of the Maharashtra Univesities Act, 1994 on behalf of the Faculty of Engineering & Technology and Academic Council,

AND

Whereas, the Schemes of teaching & examination alongwith Eligibility Criteria for admission to the above mentioned course are to be implemented from the session 2014-2015 in phase wise manner,

AND

Whereas, admissions to First Year of Master of Engineering (Full Time) course are to be made in the academic session 2014-2015,

AND

Whereas, the schemes of examination for the said course in the Faculty of Engineering & Technology are required to be regulated by the Regulation,

AND

Whereas, the process of making amendments in an Ordinance and the regulation is likely to take some time,

AND

Whereas, the syllabi along with the schemes of examinations of the above mentioned course for Semester I & II is to be made available for the students admitting during the session 2014-15.

Now, therefore, I, Dr.Mohan K.Khedkar, Vice-Chancellor of Sant Gadge Baba Amravati University, Amravati in exercise of powers conferred upon me under Sub-section (8) of Section 14 of the Maharashtra Universities Act, 1994 do hereby direct as under :-

1) This Direction shall be called "Corrigendum to Direction No. 31 of 2010 in respect of examinations leading to the Degree of अभियांत्रिकी पारंगत (Master of Engineering) (Full Time) तंत्रशास्त्र पारंगत (Master of Technology) (Full Time) (Semester Pattern . . . Credit Grade System)".

2) This Direction shall come into force with effect from the session,
   i) 2014-2015 for Semester – I & II and
   ii) 2015-2016 for Semester – III & IV.

3) The Eligibility Criteria for admission to the degree of Master of Engineering M.E.Civil (Geotechical Engineering) (Full Time) shall be as under:-

   B.E./B.Tech.Civil or Equivalent Degree of this University or any other Statutory University recognized by Sant Gadge Baba Amravati University as equivalent thereto. Similarly Diploma holders in Civil Engineering who have completed A.M.I.E. through the Institution of Engineers, (I.) Kolkata.

4) The schemes of examination of the course M.E.Civil (Geotechnical Engineering) (Full Time) be as per appendices A & B appended with this Direction.

Sd/-

Date :- 26 /08/2014   (Dr.Mohan K.Khedkar)
                                        Vice-Chancellor

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TWO YEAR POST GRADUATE DEGREE COURSE IN MASTER OF ENGINEERING (FULL TIME)
CIVIL ENGINEERING (GEOTECHNICAL ENGINEERING)
CREDIT GRADE SYSTEM

Appendix - A

FIRST SEMESTER

Sr. No.	Subject Code	Subject	TEACHING SCHEME					THEORY						PRACTICAL			
			HOURS/WEEK			Total Hours	Credits	Duration Of Paper	Max.Mark Theory Paper	Max. Mark Theory Assesment	Total	MIN.PASSING MARKS		MAX.MARKS		Total	Min.Passing Marks
			Lecture	Tutorial	Practicals							Theory Paper	Subject	External	Internal		
1	1SFGE1	Ground Improvement Techniques	4	0	0	4	4	3	80	20	100	40	50				
2	1SFGE2	Advanced Soil Mechanics	4	0	0	4	4	3	80	20	100	40	50				
3	1SFGE3	Advanced Foundation Engineering	4	0	0	4	4	3	80	20	100	40	50				
4	1SFGE4	Construction Methods in Geotechnical Engineering		0	0	4	4	3	80	20	100	40	50				
5	1SFGE5	Earth Dam Analysis and Design	4	0	0	4	4	3	80	20	100	40	50				
6	1SFGE6	Ground Improvement Techniques & Earth Dam Analysis Lab.			2	2	1							25	25	50	25
7	1SFGE7	Advanced Foundation Engineernig Lab.			2	2	1				500			25	25	50	25
			20	0	4	24	22				500					100	

Total: 600

SECOND SEMESTER

Sr. No.	Subject Code	Subject	TEACHING SCHEME					THEORY						PRACTICAL			
			HOURS/WEEK			Total Hours	Credits	Duration Of Paper	Max.Mark Theory Paper	Max. Mark Theory Assesment	Total	MIN.PASSING MARKS		MAX.MARKS		Total	Min.Passing Marks
			Lecture	Tutorial	Practicals							Theory Paper	Subject	External	Internal		
1	2SFGE1	Soil Dynamics and Machine Foundation	4	0	0	4	4	3	80	20	100	40	50				
2	2SFGE2	Finite Element Methods in Geotechnical Engineering	4	0	0	4	4	3	80	20	100	40	50				
3	2SFGE3	Geosynthetics	4	0	0	4	4	3	80	20	100	40	50				
4	2SFGE4	Elective-I	4	0	0	4	4	3	80	20	100	40	50				
5	2SFGE5	Elective-II	4	0	0	4	4	3	80	20	100	40	50				
6	2SFGE6	Soil Engineering Lab.			2	2	1							25	25	50	25
7	2SFGE7	FEM Lab.			2	2	1				500			25	25	50	25
			20	0	4	24	22				500					100	

Total: 600

Elective-I	Elective-II
i) Geoenvironmental Engineeirng	i) Geotechnical Earthquike Engineering
ii) Soil Structure Interaction	ii) Rock Mechanics
iii)Soil Stabilization	iii)Pavement Analysis and Design

		THIRD SEMESTER									
Sr.No.	Subject Code	Subject	Lecture	Tutorial	Practicals	Total	Credits	Internal Marks	Total	MIN. Passing Marks
1	3SFGE1	Seminar and Dissertation			6	6	15	100	100	50
		Total			6	6	15		100	
										Total: 100

		FOURTH SEMESTER										
Sr.No.	Subject Code	Subject	Lecture	Tutorial	Practicals	Total	Credits	External Marks	Internal Marks	Total	MIN. Passing Marks
1	4SFGE1	Seminar and Dissertation			12	12	30	200	100	300	150
		Total			12	12	30			300	
											Total 300
											Grand Total 1600

Semester III

Seminar: Seminar to be deliverd on work completed during III rd semester.50 internal marks out of 100 will be assessed by a committee consisting of head of department,dissertation guide and subject expert appointed by principle of the college/ Head of university department remaining 50 internal marks will be given by guide based on performance

Dissertation: Title of the dissertation work to be submitted to the university on or before 15 sept.(for regular examination) and 15 th of feb. (for supplimentry exam)

Semester IV:

Seminar: To be delivered on the complete work of dissertation 15 internal marks out of 100 will be assessed by a commitee consisting of head of department dissertation guide and subject expert appointed by principle of the college/Head of university department remaining 50 internal marks will be given by guide based on performance

Notes: Thesis of dissertation work must be submitted to the university on or before 30 April (For regular exam) and 30 Nov. (For supplimentry exam)

Thesis of dissertation work be submitted with late fee to the university up to 31 May (For regular exam) and 31 Dec. (For supplimentry exam) the late fee shall be charged as in cash of examination form.

Notes: 1. Students should fill the examination form in the begaining of III & IV semester

2. Single marksheet for III & IV semester together will be given to the student.

Eligibility Criteria :- B.E. /B.Tech. Civil / Equivalent. Engg./ of this University or any other Statutory University /Diploma. Similary Diploma Holders in Civil Engg. who have completed A.M.I.E. through the Institution of Engineers, (I) Kolkata.

**SYLLABUS PRESCRIBED FOR TWO YEAR
P.G.DEGREE COURSE IN
M.E. (FULL TIME) CIVIL
(GEOTECHNICAL ENGINEERING) (C.G.S.)**

SEMESTER - I

1SFGE1 GROUND IMPROVEMENT TECHNIQUES

Clay mineralogy - Atomic bonds, Clay minerals. Clay-water relations, Electrical effects,cation exchange, Clay mineral identification.

Soil stabilization – Principle, Different methods of soil stabilization Granular 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.

Deep Compaction of Granular soil – Introduction, Vibration methods – Vibration methods – Vibro-flotation, Vibro compaction, Blasting, Displacement methods. Stone-gravel and sand column, Design of stone columns, Compaction piles, Dynamic consolidation, Preloading method.

Stabilization of soft soil – Lime columns – Bearing capacity, Principle, Bearing capacity of lime group, Total and differential settlement, Application of lime column method, Quality control methods, Design of lime column foundations.
Sand drains, Granular trench stabilization

Grouting – Grouting techniques – Permeation grouting, Hydro facture grouting, Compaction grouting, Jet grouting, Types of grouts, Design of soil grouting program, Grouting equipment, Quality control and testing.

Recommended Books:

1. Principles of Foundation Engineering, B.M. Das, 5th edition, Thomson Asia Pvt. Ltd., 2004.

2. Foundation Engineering Handbook, Hsai-Yang Fang, 2nd edition, Springeri Publication, 2001.

3. Foundation Analysis and Design, J.E.Bowles, 5th edition.,McGraw-Hill, 1996.

4. Engineering Principles of ground Modifications, M. R. Hausmann, McGraw-Hill International Edition, 1990.

5. Ground Improvement, M. P. Moseley, Blackie Academics and Professionals, 1993.

6. Ground Improvement and Control, P. P. Xanthakos, L. W. Abramson and D. A. Bruce, John Wiley & Sons, 1994.

7. Engineering Principles of Ground Modifications, R. H. Manfired, McGraw-Hill, 1990.

1SFGE2 ADVANCED SOIL MECHANICS

Concept of stress, strain, Principal stresses & strains, Invariant, Octahedral Stresses & strains. Stress-strain relations, Special Matrices, Plane stress, Plane strain problems, Mohr's diagram.

Stresses & displacements in elastic soil mass – Line force, Distributed line loads, concentrated force and distributed loads at the surface of semi-infinite mass, Soil bodies exhibiting non homogeneous attributes, Influence of anisotropy in soil bodies, constitutive equations and models.

Soil strength – Yield criteria, Theories of failure, Effective stress principle, Stress path in various drainage conditions. Limiting equilibrium for analysis of slopes stability.

Earth pressure and retaining walls - Earth pressure theories, Analytical and graphical methods for determination of earth pressure, Proportioning of retaining walls, Stability analysis of retaining walls – Stability against sliding, overturning, bearing capacity and settlement.

Braced cuts – Lateral earth pressure in cuts, Stability of braced cuts Three dimensional consolidation – Equation, Solution of 3-D

consolidation equation, Consolidation by vertical sand drain and its design aspects, Free strain consolidation with no smear, Effect of smear zone on radial consolidation, Calculation of degree of consolidation with radial drains and solutions of problems based on it.

Seepage – Flow net for anisotropic soil media, Construction of flow net for hydraulic structures on non-homogeneous soil, Directional variation of permeability in anisotropic medium, Anisotropy governing differential equations for flow through porous media in Cartesian co-ordinate & polar co-ordinate systems for Laplace Equations, Numerical analysis of seepage in layered soil, computation of seepage force.

Recommended Books:
1. Advanced Soil Mechanics, B. M. Das., 2nd edition. Taylor and Francis, 1997.
2. Soil Engineering in Theory and Practice, Singh, A., 4th edition, CBS Publishers, New Delhi, 2002.
3. Soil Mechanics, R. F. Craig, Van Nostrand ReinGold Co. Ltd., 1987.
4. Soil Mechanics and Foundation Engineering, V.N.S. Murthy, CBS Publ. & Distributors, 1st edition, 2007.

1SFGE3   ADVANCED FOUNDATION ENGINEERING

Planning of subsoil exploration for major Civil engineering Projects, Methods of subsoil explorations, Choice of method, Types of samplers, Sampling methods, Criteria for spacing of bores, depth of exploration, IS recommendations.

Field Methods – Standard Penetration Test, Plate Load Test, Cone Penetration Test, Field Vane Shear Test, Geophysical Methods, Reports of subsurface explorations, Interpretation of results of field and laboratory tests

Bearing Capacity, Terzaghi's, Skemptons, Meyorhoff, BIS methods for bearing capacity

Footings: Footings with eccentric loading, moments, combined footing etc.

Raft foundations – types, Bearing capacity of rafts on sands and clay, Analysis of rigid rafts,

Modulus of subgarde reaction and its determination, Effect of depth on subgarde reaction, criteria for rigid / Flexible raft, Raft analysis using modulus of subgarde reaction, raft analysis using finite difference method and finite grid method

Sheet pile walls – Types, Construction methods, Cantilever sheet piling penetrating clay and sand, Anchored sheet pile wall – Free earth support method and Fixed earth support method, Types of anchors, Design of anchors.

Pile foundations – Static analysis of piles & pile group, negative skin friction, uplift resistance of pile, Vertical piles subjected to lateral loads, Solution with soil modulus assumed constant, short and long piles, Hansen's method, Broom's method, Reese and Matlog method, Use of p-y curves, Deflection of vertical piles, Batter pile groups under inclined load, Culman's method, Analytical method, Hrehnikoffi's method, Brill's approach, Design of pile cap

Cellular cofferdams – Types, components, stability analysis, design of cellular cofferdams

Well foundations – Components and their functions, Different shapes, Sinking procedure,
Tilts and shift, Sinking stresses, Depth of well foundation, Bearing capacity of wellfoundation, Loading on well foundation, Lateral stability of well foundation, Different methods of analysis – Terzaghi's analysis, Banergee and Gngopadhyay's method, IRC method, Design of components of well foundation.

Recommended Books:
1. Foundation Analysis and Design, J.E.Bowles, 5th edition.,McGraw-Hill, 1996.
2. Design Aids in Soil Mechanics and Foundations, S.R Kaniraj., 2nd edition, McGraw Hill, 1995.
3. Pile Design and Construction Practice, M. J. Tomlinson, Chapman & Hall Pub., 1994.
4. Design of foundation System: Principles and Practices, N. P. Kurian, 3rd edition, Narosa Publishing House, 2005.
5. Theory and Practice of Foundation Design, N. N. Som and S. C. Das, PHI Learning Pvt. Ltd., 2009.

6. Pile Foundation Analysis and Design, H. G. Poulus and E. H. Davis, John Wiley & Sons, 1980.
7. Foundation Engineering Handbook, R. W. Day, McGraw Hill, 2005.
8. Soil Mechanics and Foundation Engineering, V.N.S. Murthy, CBS Publishers &Distributors, 1st edn., 2007.

1SFGE4 CONSTRUCTION METHODS IN GEOTECHNICAL ENGINEERING

Methods of Dewatering Construction of Raft Foundation.

Pile foundation - Pile driving equipment – Hammer, Pile drivers and other accessory equipment, Construction of precast and cast-in-situ piles.

Cofferdams - Sheet piling in cofferdams – Setting and driving, Length and penetration, splicing, Extraction, Scaling to existing structures, Bracing systems – Circular cofferdams, Rectangular Cofferdams, Setting, Bracing, Removing bracing, Excavation – Pre-dredging, excavation inside cofferdams.

Pile driving within the cofferdam – Bottom seal – Resistance to uplift, Seal construction by bucket method, Seal construction by Tremic method, Seal construction by grout intrusion method, Dewatering – Pumping, other dewatering methods, Cofferdam difficulties – Cofferdam destroyed by surge, Cofferdam bottom blows, Improper sheet pile sections and bracing, Sheet pile stopped by boulders, Buckling of long struts, Improper procedure in unstable soil, Scour and poor Tremic-concrete procedures, problems with Tremic.Box

Caissons – General considerations, Site and foundation preparation, fabrication, Launching and Towing, Setting, Concreting.

Open Caissons – General considerations, Cutting edges, Setting, Construction of steining, sinking, Tipping and sliding, completing and installation, Construction of Pneumatic Caissons.

Rock excavation – Evaluation and planning, Drilling equipment, Blast design – Criteria for design, Selection of explosive, Blast hole design, Blasting round design, Over break Control –

Line drilling, Pre-splitting; Trim blasting, Loading and hauling equipment

Tunneling in solid rocks – Means of excavation in solid rocks, Full-face tunneling without Support, Full-face tunneling with support Tunneling in moderately firm rocks and ground Classical or mining method, Single stage mining method, multistage classical method of tunneling, Sinking caisson method, Shield tunneling method, tunneling by Tunnel boring Machines, Types of TBM

Recommended Books:
1. Handbook of Heavy Construction, John Havers and Frank W . Stubbs, McGraw Hill, 1971.
2. Construction & Geotechnical Methods in Foundation Engineering, R. M. Koerner, McGraw Hill,1985.
3. Tunneling Management by Design, A. M. Wood , Windle edition.
4. The Introduction to Tunnel Construction, David Chapman, Nicole Metje & Alfred Stärk , Spon Press, 2010.

1SFGE5 EARTH DAM ANALYSIS AND DESIGN

Types of earthen dams – based on construction materials, Methods of construction, and foundation, Requirements of good dam site, Causes of failure, Design criteria for safe design, Preliminary section, typical cross sections of earthen dams.

Seepage through earthen dam – Laplace Equation, Phreatic line and its determination for homogeneous and non-homogeneous sections under different conditions, Flow net for seepage, Various methods for constructing flow net, Seepage analysis for uniform and zoned sections, Methods of Seepage control through embankment and foundation of earthen dam, Design of impermeable blanket.

Drainage of Earthen dam – Provision of filters, Design of filter, Surface protections, Relief wells.

Stability analysis – Construction pore pressure and factors affecting it, Stability of slopes during construction, Pore pressure measurement – Bishop's method, Hilf's method, Approximate method.

Stability of upstream and downstream slopes – Method of slices, Bishop's method, Effective stress analysis, Stability during steady seepage and sudden drawdown Stability of foundation against hear.

Stability analysis considering earthquake forces, Design considerations for earth dam in Seismic region.
Embankment construction procedure – Equipment, Methods of quality control, Instrumentation system for measurement of various parameters Case studies of dam failure Rock fill dams – Types, Characteristics, Material, foundation, design of dam section, Construction.

Recommended Books:

1. Earth and Rockfill Dam Engineering, G.F. Sowers, Asia Publishing House,1972.

2. Earth and Earth Rock Dams, J.L. Sherard, John Wiley & Sons, 1963

3. Engineering for Embankment Dams, Bharat Singh and R. S. Varshney, Oxford & IBH Publishing Co. Pvt. Ltd., 1995

4. Irrigation Engineering, R. K. Sharma and T. K. Sharma, S. Chnad & co., New Delhi, 2007.

1SFGE6   Ground Improvement Techniques & Earth Dam Analysis Lab.

Minimum eight experiments to be performed .

1) Design of Vertical Sand drains

2) Design of stone column

3) Design of lime Column

4) Field visit to Grouting sites/sand drains/stone column site.

5) Design of impervious blanket stone column

6) Design f Earth Dam (Homogeneous section)

7) Seepage analysis of earthen dam by flow net.

8) Field visit to earthen dam

9) Determination of field density of soil by using core cutter method.

1SFGE7   Advanced Foundation Engineering Lab.

Minimum eight experiments to be performed.

1. Standard penetration Test
2. Cone Penetration Test
3. Plate Load Test.
4. Field Vane Shear Test.
5. Design of Pile foundation
6. Design of Raft foundation
7. Design of Well foundation
8. Design of anchored sheet pile wall fixed earth support method
9. Design of anchored sheet pile wall free earth support method
10. Determination of Permeability of falling head test.
11. Determination of shear strength parameter by direct shear test.
12. Determination of shear strength parameter by Triaxial of UU type

SEMESTER - II

2SFGE1   SOIL DYNAMICS AND MACHINE FOUNDATION

Theory of vibrations – Introduction to dynamic loading, Vibratory motions, Harmonic motion, Single degree of freedom system- free and forced vibrations, damped and un-damped vibrations, Systems with two degree of freedom, Un-damped dynamic vibration absorbers.

Wave propagation- vibrations in rod (infinite and finite) - Longitudinal and torsional vibrations, Wave propagation in an infinite homogeneous isotropic elastic medium, Wave Propagation in elastic half space.

Dynamic soil properties- different laboratory tests and field tests, Factors affecting the modulus of soil, Dynamic bearing capacity of shallow foundation, Dynamic analysis- Triandafilidis's solution, Wallace's solution, Chummar's solution.

Types of machine foundations, General requirements of machine foundation, Design criteria.
Foundations of reciprocating machines- modes of vibrations, Linear elastic weightless spring method, elastic half space method, Effect

of footing shape on vibration response, Dynamic response of embedded block foundation.

Foundation of impact type machines- dynamic procedure for hammer foundations, Foundation of rotary machine – design criteria, Two dimensional analysis – Resonant method, Amplitude method and combined method.

Vibration isolation- methods of isolation in machine foundations, Isolating materials and their properties Constructional details of machine foundations.

Recommended Books:

1. Handbook of Machine Foundation , Srinivasunlu and Vaidyanathanan, Springer Netherlands, 2008.

2. Soil Dynamic and Machine Foundation, Swami Saran, Second edition, Galgotia Publication, 2009.

3. Vibrations of Soils and Foundations, F. E. Richards J. R. Hall and R. D. Woods, PHI, 1970.

4. Vibration Analysis and Foundation Dynamics, N. S. V. Kameswara Rao, Meeler Pub., 1998.

5. Foundation for Machines: Analysis and Design, Samsher Prakash and V. K. Puri, JohnWiley & Sons, 1998.

6. Soil Dynamics, Samasher Prakash, MGH, 1981.

2SFGE2   FINITE ELEMENT METHODS IN GEOTECHNICAL ENGINEERING

Introduction to advanced solid mechanics – elasticity, stress, strain & kinematics, linear constitutive equation, Plain stress, plain strain, axisymmetric structures

Standard discrete system, Stiffness matrices, Assembly and analysis of a structure, Boundary Conditions

Direct formulation, Displacement approach as a minimization of total potential energy, Virtual Work method, Relation to Rayleigh-Ritz method, Galerkin's method, Convergence criteria, Non-confirming elements and Patch test.

Rectangular element family, elements in natural coordinate system, Lagrange family,Serendipity family, Internal nodes and node-less variables, Triangular element family – area co-ordinates, shape functions, Constant strain triangles, 1-D and 3-D elements – Rectangular prism, Tetrahedral elements.

Plane stress and plain strain analysis – Element characterization and some applications, Axisymmetric   stress analysis - Element characterization and some applications, Element shape functions – 2-D elements, Pascal triangle Interface elements, Hierarchical shape functions, co-ordinate transformations.

Computer programming for FEM – Data input module, Flow chart, Subroutines for assemble, Shape functions, Mesh generation, Stiffness matrix, Solution of simultaneous linear algebraic equation.

Analysis of field Geotechnical Problems by Finite element solutions - Beam on elastic foundation, Mat foundation, Ring foundation, Pile foundation, Braced excavations, Sheet pile walls, Stability of slopes, Stress and deformations in embankments, Seepage analysis, 1-D consolidation.

Recommended Books:

1. Introduction to Finite Element Methods, C. S. Desai and J. F. Abel , 1st edition, CBS Pub., New Delhi, 1989.

2. Concepts and Applications of Finite Element Analysis: R. D. Cook, Third Edition, Wiley India Text books, Wiley India Pvt Limited, 1989.

3. Introduction to Finite Elements in Engineering, Chandragupta T. R. and Belegundu A. D., 3rd edition, Prentice Hall, 2002.

4. Finite Element Analysis: Theory and Programming: C. S. Krishnamurthi, Second Edition, Tata Mc Graw Hill Publishing Company Limited, 1994, Reprint 2005.

5. The Finite Element Method for Engineers, K. H. Huebner, D. L. Dewhirst, D. E. Smith and T.G. Byrom, 4th edition, John Wiley and Sons, Inc., 2001.

6. Matrix and Finite Element Analysis of Structures, Madhujit Mukhopadhyay and Abdul Hamid Sheikh, First Edition, Ane books Publication, 2004.

7. The Finite Element Method (Volume -I): O. C. Zienkiewicz and R. L. Taylor, 5th edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1989

2SFGE3   **GEOSYNTHETICS**

Overview of Geosynthetics materials, Types of geosynthetics, Functions, Applications of geosynthetics in engineering field.

Geotextiles – Types, Physical, Mechanical, Hydraulic, Constructability and durability properties, Test methods, Requirements of geotextiles as reinforcement, Applications of geotextiles.

Geogrid - Physical and mechanical properties, Test methods, Geogrid-soil interaction.

Geomembranes – Physical, Chemical, and Mechanical properties, Current uses Erosion control – Wind erosion, Rain water erosion, Use of geotextile, Geotextile beneath rock rip-rap, Geotextile filters – Design criteria, Construction criteria, Erosion control measures using Geogrids, Erosion control mattresses, Geotextile silt fences for erosion control.

Bearing capacity improvement – Soil mass reinforcement geometry, Mechanism, Modes of failure (Binquet and Lee theory), Foundation on soil with geotextile reinforcement, Design procedure.

Pavement construction using Geotextile – Mode of action, design methods, Construction methods.

Reinforced retaining walls – Geotextile reinforced walls – Construction procedure, Analysis, Design, Design of gabion walls using Geotextile, Geogrid soil walls – Construction, Design Filtration and drainage using geotextile – Geotextile chimney drains and their design. Containment systems using geomembarne – Liquid containment, Solid containment. Stabilisation using geogrid mattresses – Principle, Design, Construction

Recommended Books:
1. Engineering with Geosynthetics, G.V.Rao and G.V.S.S Raju, Tata-McGraw Hill Publication, New Delhi,2004.
2. Construction and Geotechnical Engineering using Synthetic Fabrics, R.M. Koerner & J.P. Welsh, John Willey and Sons, 1980.

3. Construction and Geotechnical Methods in Foundation Engineering, R. M .Koerner, McGraw Hill Publication, 1985.
4. Designing with Geosynthetics, R.M. Koerner, 4th edition, PHI, 1997.
5. Fundamentals of Geosynthetic Engineering , Sanjay Kumar Shukla and Jian-Hua Yin, Taylor and Francis Group UK, 2002
6. Reinforced Soil and its Engineering Applications, Swami Saran, 1st edition, I. K. Internationals, 2006.

2SFGE4   ELECTIVE – I
(i) GEOENVIRONMENTAL ENGINEERING

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.

Waste management – Recycling, Composting, Insiration, and various disposal methods, Site selection, Leachet collection and detection system

Types of land fills – Silting criteria, Waste containment principle, Types of barrier materials, 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, Engineering properties and Geotechnical reuse of waste, Demolition of waste etc., 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.

Recommended Books:

1. Geotechnical Practices for Waste Disposal, D.E Daniel, Chapman and Hall, London,1993

2. Geo-environmental Engineering Principles and Application, L.N. Reddy and H.F. Inyang, Marceal Dekker Inc., 2000

3. Introduction to Environmental Geotechnology, Hsai-Yang Fang, CRC Press ,1997

4. Geotechnical & Geoenvironmental Engineering Handbook, R. K Rowe, Klower Academic Publishers, 2001.

5. Waste Containment Systems, Waist stabilization & Landfills, Design & Evaluation, H. D. Sharma and S. P. Lewis, John Willey and Sons, 1994.

6. Geoenvironmental Engineering, H. D. Sharma and K. R. Reddy, John Willey and Sons, 2004.

7. Geoenvironemntal Engineering, R N Yong and H R Thomas, Thomas Telford, 1997.

2SFGE4   ELECTIVE – I
(ii) SOIL STRUCTURE INTERACTION

Introduction to Soil-Foundation interaction - Idealized soil behavior, Foundation behavior, interface behavior.

Idealized soil response model for analysis of soil foundation interaction – Elastic models of soil behaviour - The Winklers model, Elastic continuum models, Two-parameter elastic models, Elastic plastic and time dependent behaviour of soil masses – elastic-plastic behaviour, time dependent behavior

Plane-strain analysis of an infinite plate and an infinitely long beam – Bernoulli's-Euler beam theory and its modifications, Plain strain analysis of the finite plate problem, Reissner's method of analysis of the infinite plate problem, Deflection of an infinite plate on a Winkler medium.

The analysis of beams of finite length – Finite beams on a Winkler medium, Finite beams on a two-parameter elastic medium, Finite beams on an elastic solid medium, approximate methods, Classification of finite beams in relation to their stiffness

Analysis of finite plate – Axisymmetric loading of a circular plate, Analysis of rigid circular plate, analysis of rectangular plate, Plate resting on an elastic half space – Approximate method of analysis

Experimental investigation and field studies – Stress measurement beneath rigid footings, flexible beam and raft foundation
Analysis of axially loaded and laterally loaded piles.

Recommended Books:

1. Elastic analysis of Soil Foundation Interaction, A. P. S. Selvadurai, Elsevier Publishing Comp.,1979

2. Soil Structure interaction, N.P Kurian., Prentice Hall, 1997.

3. Foundation Analysis, R.F.Scott, Prentice Hall,1981

4. Pile foundation Analysis & Design, H. G. Poulos & E. H. Davis, John Wiley & Sons,1980

5. Foundation Engineering Handbook, H. Y. Fang, 2nd edition, CBS Pub., 1997.

6. Soil Mechanics and Foundation Engineering, V.N.S. Murthy, CBS Publs & Distributors, 1st edn, 2007.

7. Foundation Analysis and Design, J. E. Bowels, 5th edition, McGraw-Hill, 1996

2SFGE4 ELECTIVE – I
(iii) SOIL STABILIZATION

Objectives of soil stabilization. Classification of stabilizing agent and stabilization processes, nature and surface characteristics of soil particles, concepts of surface area and contact points.

Drainage and compaction, principles of mechanical stabilization, inorganic stabilizing agents and their characteristics- lime, cement, lime-fly- ash, hydroxides, carbonates etc., inorganic stabilizers, reaction mechanism in relation to strength improvement, characteristics under various condition of soil properties, time, temperature and stress.

Deleterious effect of organic substance and sulphates on inorganic stabilization, organic stabilizers, binding and water-proofing agents-

bituminous materials, lignin, large organic cations, aniline furferols resins, rosins and derivatives and other organic wastes, bituminous stabilization, electrical and thermal stabilization.

Recommended Books:

1. Manfred R. Huasmann : Engg. Principles of Ground Modifications, Mcgraw Hill International.

2. Physical & geotechnical properties of soils- Joseph E.Bowels, Tata Mc-grawhill

3. Advanced soil mechanics- Braja M.Das, Tata Mc-Grawhill

4. Proceedings of conference on Soil Stabilization, Massachussets Institute of Technology, June 18-30, 1959.

5. K.B.Woods, D.S.Berry and W.H.Goetz, Highway Engineering Handbook, 1960.

2SFGE5 ELECTIVE – II
(i) GEOTECHNICAL EARTHQUAKE ENGINEERING

Seismology and Earthquakes – Internal structure of earth, Continental Drift and Plate Tectonics, Faults, Elastic Rebound Theory, Other sources of seismic activity, Geometric Notation, Location of Earthquake, Size of Earthquake.

Strong Ground Motion - Strong Motion measurement, ground motion Parameters, Estimation of ground Motion Parameters, Spatial Variability of Ground Motions.

Seismic Hazard Analysis – Seismic Hazards, Identification and Evaluation of Earthquake Sources, Deterministic Seismic Hazard Analysis, Probabilistic Seismic Hazard Analysis.
Wave Propagation – Waves in Unbound Media, Waves in Semi-infinite Body, Waves in Layered Body, Attenuation of Stress Waves.

Dynamic Soil Properties – Representation of stress conditions by the Mohr Circle, measurement of Dynamic Soil properties, stress-strain behaviour of cyclically loaded soils.Ground response analysis – 1-D ground response analysis, 2-d ground response analysis, 3-dD ground response analysis, Soil-structure interaction.

Local Site effects and design ground motions – effects of local site conditions on ground motion, Design parameters, Development of design parameters, Development of ground motion time histories

Liquefaction – Liquefaction phenomenon, Evaluation of liquefaction hazards, Liquefaction Susceptibility, Initiation of liquefaction, Effects of liquefaction.

Seismic Slope stability – Types of earthquake induced landslides, Earthquake induced landslide activity, Evaluation of slope stability analysis, Seismic slope stability analysis. Stability of earthen dam during earthquake – Types of damage, Response analysis of embankment dams – visco-elastic response analysis, Jai Krisna approach, Seed and Martin approach, Development of deformation analysis – Goodman and Seed approach, Seed approach to non-free-draining and cohesive soils, Design recommendations and precautions Analytical methods of dynamic analysis for earth dam and embankments

Seismic design of Retaining wall – Dynamic response of retaining walls, Seismic pressure on retaining walls, seismic displacement of retaining walls, Seismic design considerations Soil improvement for remediation of seismic hazards – Densification techniques, Reinforcement techniques, Grouting and mixing techniques, Drainage techniques, Verification of soil improvement.

Bearing capacity analysis for earthquake, Foundation alternatives to mitigate earthquake. Effects Earthquake induced settlement.

Recommended Books:

1. Geotechnical Earthquake Engineering, Steven L. Kramer, Prentice Hall Publication, 1996

2. Geotechnical Earthquake Engineering Hand Book, R. W. Day McGraw Hill Publication, 2001

3. Geotechnical Engineering Investigation Manual, R. E. Hunt, McGraw Hill Publication, 2005

4. Soil Dynamics & Machine Foundation, Swami Saran, 2nd edition, Galgotia Publications Pvt. Ltd., New Delhi,1999.

5. The Seismic Design Handbook, F. Naeim, 2nd edition, Kluwer Academic Publ., 2001.

2SFGE5 ELECTIVE – II
(ii) ROCK MECHANICS

Introduction to Rock Mechanics and its field applications, Identification of common rocks, Physical and mechanical characteristics of rock material, Field and laboratory testing of rocks, Classification of rock masses for engineering purpose.

Rock excavation and reinforcement – Drilling, Blasting, Braking and cutting, Rock bolting, Rock anchors, Bolted and anchor supports, Rock grouting - Types of treatment, grouting material, grouting methods, Grouting design and layout.

Stresses in rock mass – Types of stresses, in-situ stress determination methods – Over coning, Flat jack method, Hydraulic fracturing, Structural Geology and Ground stresses, Stresses around underground opening, stresses in tunnels and shafts, Strains and deformations around circular opening, Rheology

Rock strength and Deformability - Modes of rock failure, Stress-strain behavior in compression, Mohr-Coulomb failure criteria, Hook-Brown criteria, Griffth's crack theory, Empirical criteria for failure, Effect of size on strength, Anisotropic rocks, Plane of weakness in Rocks, Joint orientation and roughness, Deformability of rocks – Elastic and non-elastic behavior, influence of time on rock deformation, viscous behavior and creep.

Brittle failure of Rocks – Introduction, Fracture initiation, Fracture propagation, Rock fracture in compression, Rupture criteria for brittle rock, Factors affecting rupture behavior of rock.

Ultimate behavior of rock structures – Plasticity and resistance of rock structure, Principle of limit equilibrium method, analysis of general slip surfaces, Approximate methods for two dimensional limit equilibrium analysis, Structural discontinuities in rock masses and progressive failure, Water pressure and resistance of rock structures.

Rock foundations - Allowable bearing pressures, Stress and deflection in rock under footing, Failure mechanisms, Subsiding and swelling rocks, Base heave and remedies, foundation Anchoring

Rock slopes – Modes of failure, Factors affecting, Analysis of slopes Underground opening - Opening in competent rock, horizontally layered rocks and rock with inclined layers, Plastic behavior around tunnels, time dependent behavior of tunnels, underground opening in blocky rocks- Block theory, Review of dsign methods of tunnels – Empirical and semi-empirical methods, Support and stabilization.

Recommended Books:

1. Introduction to Rock Mechanics, R.E. Goodman, 2nd edition, John Wiley & Sons Publication, 1989.
2. Stresses in Rock, G. Herget, Balkema, 1988.
3. Rock Characterization, Testing and Monitoring, F. T. Borwn, Pergamon Press, 1986.
4. Rock Mechanics for Underground Mining, B. H. G. Brady and F. T. Borwn, Chapman and Hall, 1993.
5. Fundamental of Rock Mechanics, J. C. Jaeger and N. G. W. Cook, Chapman and Hall, 1976.
6. Foundations on Rock, D. C. Wyllie, 2nd edition, E&FN Spon, 1992.

2SFGE5 ELECTIVE – II
(iii) PAVEMENT ANALYSIS AND DESIGN

General: Structural action of flexible and rigid pavements. Characteristics of highway and airfield pavements.

Design parameters: Standard Axial load and wheel assemblies for road vehicles under carriage system for aircraft, Tire and contact pressure, contact area imprints, Computations of ESWL for flexible and rigid pavements. Load repetitions and distributions of traffic for highway and airfield pavement, airport traffic areas.

Material Characteristics: AASHO subgrade soil classification. Group index, CBR, North Dakota cone bearing value, plate load test for "K", Marshal's method of Bituminus mix design. Modulus of rupture and elasticity, poison's ratio &coefficient of thermal expansionof concrete. Layer equivalency concepts.

Analysis of Flexible and Rigid Pavements : Stress, Strain deformation analysis for single, two, three and multilayered flexible pavement systems. Stress and deflections for rigid pavements due to load and

temperature, influence Charts, ultimate load analysis, joints in pavements.

Highway Pavement Design: Flexible: North Dakota cone, Group index, CBR, IRC-37,Brumister, Triaxial (Kansas), AASHO method of design , RIGID, IRC-58, P. C. A., Design of joints and reinforcement.

Airfield Pavement Design: Flexible: U. S. Crops of Engineering, CBR, FAA, Mcload(Canadian); Rigid: PCA, FAA & LCN, ultimate load Analysis yield lines pattern, methods.

Pavement Testing and Evaluation : Trial and Inspection Pits, Field Density, CBR, plate load test, condition surveys and surface evaluation for unevenness, rut depth, profilometers, Bump integrators, Benkalman Beam Deflection Study.

Recommended Books:

1. Principles of Pavement Design, Yoder & Witzace; Prentice Hall,2000

2. Pavement Analysis and Design, H. H. Yang, Pearson Prentice Hall, 2004.

3. Airport Planning & Design, Goyal & Praveen Kumar; Galgotia Publication, 2002

4. Design and Performance of Road Pavements, Croney & Croney, McGraw Hill, 2002

5. Airport Planning and Design, S K Khanna, M. G. Arora, S S Jain, 6th edition, Nemchand & Bros,   Roorkee, 1999.

6. Highway Engineering; K. Khanna, and Justo, C.E.G., Khanna Publication, Roorkee, 2001

2SFGE6 SOIL ENGINEERING LAB.

Minimum eight experiments to be performed .

1. Geophysical methods- Electrical Resistivity Method/ Sounding test.
2. Field visit of soil investigation site
3. Moisture- density relation of stabilized soil
4. Wetting and drying test of compacted stabilized soil
5. Design and stability analysis of retaining wall
6. Determination of earth pressure by graphical Method/ using GEO5 Software

7. Determination of flow through hydraulic structure on non homogeneous soil
8. Determination of CBR test.
9. Determine unconfined compressive test.

2SFGE7 FINITE ELEMENT METHODS LAB.

Computer programme modules for FEM shall be prepared and introduction to any FEM software.
A Report based on above experiments shall be submitted by each student.

Practical Examination:
Practical examination shall consist of oral examination based on Report.

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