(5)

GOVT. COLLEGE OF ENGINEERING, AMRAVATI

DEPARTMENT OF CIVIL ENGINEERING

PROPOSED CURRICULUM

For

M. TECH. (Geotechnical Engineering)

2019- 2020

Specialization: GEOTECHNICAL ENGINEERING

PROGRAM OBJECTIVES

1. To make students learn the principles of soil and rock mechanics. Understand different problems associated with geotechnical engineering. Explain how to select design soil/rock parameters for design purpose based on the subsurface exploration. Develop Analysis and Design procedure for various geotechnical structures.
2. Students should gain competency in the design of shallow/deep foundations, earth retaining structures, embankment and earthen dams, underground structures. Can assess stability of slopes and apply preventive measures for stability.

PROGRAM OUTCOMES (POs):

1. Students will learn soil and rock behaviour. Students will be able to perform various laboratory and in-situ tests on soil/rock to find out design parameters.
2. Students can design shallow/deep foundations, earth retaining structures, embankment and earthen dams, tunnel support systems for given site conditions.
3. Student can compute factor of safety to assess stability of slopes and apply preventive measures for stability.
4. Student can develop numerical models to estimate response of various geotechnical structures under different loadings.

M. Tech. (Geotechnical Engineering)

Sem -I

Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	TA	MSE	ESE	ICA	ESE		
PC	CEP151	Advanced Soil Mechanics	3	-	-	3	10	30	60	-	-	100	3
PC	CEP152	Advanced Foundation Engineering	3	-	-	3	10	30	60	-	-	100	3
PE	CEP154	Program Elective – I	3	-	-	3	10	30	60	-	-	100	3
PC	CEP153	Ground Improvement Technology	3	-	-	3	10	30	60	-	-	100	3
PL	CEP155	Geotechnical Engineering Lab I	-	-	6	6	-	-	-	50	50	100	3
PS	CEP156	Seminar I	-	-	4	4	-	-	-	50	-	50	2
HSMC	SHP121	Audit Course I	-	-	-	-	-	-	60	-	-	60	0
		Total	**12**	**-**	**10**	**22**	**40**	**120**	**360**	**100**	**50**	**610**	**17**

LIST OF PROGRAM ELECTIVES

PROGRAM ELECTIVE I	
(A) Earth dam analysis & Design	(B) Computational Geomechanics
(C) Design of Underground structures	

LIST OF AUDIT COURSES

AUDIT COURSES	
(A)English for Research Paper Writing	(B) Disaster Management
(C)Sanskrit for Technical Knowledge	(D)Value Education
(E)Pedagogy Studies	(F) Stress Management by Yoga
(G)Personality Development through Life Enlightenment Skills. (H) Constitution of India	

M. Tech. (Geotechnical Engineering)

SEM- II													
Cate-gory	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	TA	MSE	ESE	ICA	ESE		
PC	CEP251	Dynamics of Soil and Foundations	3	-	-	3	10	30	60	-	-	100	3
PC	CEP252	Geotechnical Investigations & Construction practices	3	-	-	3	10	30	60	-	-	100	3
PC	CEP253	Pavement Analysis & Design	3	-	-	3	10	30	60	-	-	100	3
PE	CEP254	Program elective II	3	-	-	3	10	30	60	-	-	100	3
MC	SHP221	Research Methodology	2	-	-	2	10	30	60	-	-	100	2
PL	CEP255	Geotechnical Engineering Lab II	-	-	6	6	-	-	-	50	50	100	3
PS	CEP256	Seminar II	-	-	4	4	-	-	-	50	-	50	2
			14	**00**	**10**	**24**	**50**	**150**	**300**	**100**	**50**	**650**	**19**

LIST OF PROGRAM ELECTIVES

PROGRAM ELECTIVE II

(A) Geotechnical Earthquake Engineering (B) Environmental Geo-technology (C) Foundation on weak soil

M. Tech. (Geotechnical Engineering)

Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme						Credits
							Theory			Practical		Total	
			Theory Hrs /week	Tutorial Hrs/week	Practical Hrs/week	Total	TA	MSE	ESE	ICA	ESE		
PE	CEP351	Program Elective III	3	-	-	3	10	30	60	-	-	100	3
OE	SHP321	Open Elective	3	-	-	3	10	30	60	-	-	100	3
PROJ	CEP352	Dissertation Stage I	-	-	20	20	-	-	-	100	-	100	10
	Total		**06**	00	20	**26**	**20**	**60**	**120**	**100**	**-**	**300**	**16**

LIST OF PROGRAM ELECTIVES

PROGRAM ELECTIVE III	OPEN ELECTIVE
(A) Finite Element Method in Geomechanics (B) Engineering Rock Mechanics (C) Earth Retaining Structures	(A) Business Analytics (ME) (B) Industrial Safety (ME) (C) Operations Research (ME) (D) Cost Management of Engineering Projects (CE) (E) Composite Materials (ME) (F) Waste to Energy (CE) (G) Finance Management (EE)

(H) Project Management (EE)

(I) Data Structure and Algorithms (CS)

(J) Any other courses approved by BOS

Note:-

ME:- Offered by Mechanical Engineering Department

CE:- Offered by Civil Engineering Department

EE:- Offered by Electrical Engineering Department

CS:- Offered by Computer Science and Engineering Department

M. Tech. (Geotechnical Engineering)

SEM - IV													
Category	**Course Code**	**Name of the Course**	**Teaching Scheme**				**Evaluation Scheme**					
							Theory		**Practical**		**Total**	**Credits**
			Theory Hrs /week	**Tutorial Hrs/week**	**Practical Hrs/week**	**Total**	**MSE**	**ESE**	**ICA**	**ESE**		
PROJ	CEP451	Dissertation Stage II	-	-	32	32	-	-	200	200	400	16
	Total		-	-	32	**32**	-	-	**200**	**200**	**400**	**16**

COMPARISON OF SEMESTER-WISE CREDIT DISTRIBUTION IN OLD AND PROPOSED STRUCTURE

SEMESTER	CREDITS IN OLD CURRICULUM	CREDITS IN PROPOSED CURRICULUM
I	25	17
II	25	19
III	10	16
IV	30	16
Total	90	68

Department of Civil engineering

Equivalence Scheme

Programme Name:-M. Tech. Geotechnical Engineering

Sr. No.	Course code with Name of course(old)		Credit	Course code with Name of course (new)		Credit
1.	CEP121	Computer Programming & Numerical Methods	04	-	-	-
2.	CEP122	Advanced Soil Mechanics	04	CEP151	Advanced Soil Mechanics	03
3.	CEP123	Advanced Foundation Engineering	04	CEP152	Advanced Foundation Engineering	03
4.	CEP124	Ground Improvement Techniques	04	CEP153	Ground Improvement Technology	03
5.	CEP125	Earth Dam Analysis and Design	04	CEP154 (A)	Earth dam analysis & Design	03
6.	CEP126	Geotechnical Engineering Laboratory-I	04	CEP156	Geotechnical Engineering Laboratory-I	03
7.	CEP127	Seminar-I	01	CEP156	Seminar I	02
8.	CEP221	Soil Dynamics and Machine Foundation	04	CEP251	Dynamics of Soil and Foundations	03
9.	CEP222	Finite Element Methods in Geotechnical Engineering	04	-	-	-
10.	CEP223	Geosynthetics	04	-	-	-
11.	CEP224	Elective-I, (C) Construction Methods in Geotechnical Engineering	04	CEP252	Geotechnical Investigations and Construction Practices	03
12.	CEP225	Elective-II, (C) Pavement Analysis and Design	04	CEP253	Pavement Analysis and Design	03
13.	CEP226	Geotechnical Engineering Laboratory-II	04	CEP255	Geotechnical Engineering Laboratory-II	03
14.	CEP227	Seminar-II	01	CEP256	Seminar - II	02
15.	CEP321	Dissertation (Phase-I)	10	CEP352	Dissertation Stage I	10
16.	CEP421	Dissertation (Phase-II)	30	CEP451	Dissertation Stage II	16

CEP151ADVANCED SOIL MECHANICS

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. To impart the knowledge of consolidation theory for determination of consolidation settlement and time required.

II. To enhance the knowledge of strength theories for determination of shear strength of soil for different field conditions.

III. To provide the knowledge of stress path and Critical state soil mechanics and Elastic and plastic deformations to develop mathematical models for solving different problems in soil mechanics for different field conditions.

Compressibility of soils: Introduction, factors affecting consolidation, measurement of various consolidation characteristic, one way two way drainage, degree of consolidation, Terzaghi's one-dimensional consolidation equation, consolidation theory (one, two, and three dimensional consolidation theories), determination of pre-consolidation pressure, determination of coefficient of consolidation, field consolidation time for NC and OC clays, secondary consolidation, swell-pressure consolidation in layered soil,

Strength behavior of soils; Basic concept, Mohr-Coulomb Theory; measurement of shear strength, drainage conditions along with field problems, UU, CU, CD tests, drained and undrainedbehavior of sand and clay, factors affecting shear strength of cohesive and cohesionless soil, Skempton's pore pressure parameters, Hvorslev's shear strength parameters, significance of pore pressure parameters, determination of shear strength of soil; Interpretation of triaxial test results.

Stress path; Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

Critical state soil mechanics; Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. Critical void ratio; effect of dilation in sands; different dilation models

Elastic and plastic deformations: elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule

Reference Books:

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to Critical soil mechanics, McGraw Hill, 1978.

2. Atkinson J.H, An introduction to the Mechanics of soils and Foundation, McGraw- Hill Co., 1993.
3. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997.
4. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.
5. Craig, R.F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
6. Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
7. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley & Sons, 1979.

Course Outcomes:

After Completion of course students will able to

CEP151.1 Explain one dimensional and three-dimensional consolidation characteristics and secondary consolidation in clays and determine the consolidation settlement and time from the given data.

CEP151.2 Describe Stress-strain characteristics of soils, failure mechanism, various factors affecting the shear strength of soil, effective stress phenomenon and determine shear strength parameters of soil for different types of soil and field conditions.

CEP151.3 Describe different test procedures to determine the shear strength of soil.

CEP151.4 Summerize stress path and Critical state parameters and yield curve and yield surface for different practical situations.

CEP152 ADVANCED FOUNDATION ENGINEERING

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Provide knowledge of various methods of soil explorations, their suitability and preparation of investigation reports.

II. Impart knowledge of design procedure for various shallow and deep foundations as per relevant IS codesand based on various criteria and different field situations.

III. Determination of Foundation settlements.

COURSE CONTENTS:

Planning of soil exploration for different projects, methods of subsurface exploration, methods of borings along with various penetration tests

Shallow foundations
Requirements for satisfactory performance of foundations, Terzaghi's, Meyerhoff, Hansens bearing capacity theories, Types of shear failures, Effect of water table on bearing capacity, layered soils, eccentric and inclined loads, Bearing capacity on slopes, Annular Footings, Rigid and flexible foundations, Plate load test, Design of Individual, Combined and Raft Foundations for axial and bending loads (Uniaxial and biaxial)

Foundation settlements, settlements of footings and rafts, proportioning of foundations using field test data, IS codes.

Pile foundations
Introduction, classification, Load transfer mechanism, Static and dynamic formulas for pile capacity in various soil types, settlements of pile foundations, pile group capacity and settlement, negative skin friction of piles, laterally loaded piles, pile load tests, lateral and uplift capacity of piles, Analysis and design of pile and pile cap

Drilled Piers and Caissons
Introduction, types, Construction of drilled piers, advantages and disadvantages, Design considerations, bearing capacity equations, Settlements, Types of caissons, stability analysis, advantages and disadvantages of caissons

Well foundation
Different shapes of well, grip length, forces acting on well foundation, Trezaghi's analysis, components of well, sinking of wells, measurement and rectification of tilts and shifts, IS and IRC codal provisions,

Foundations on problematic soils: Foundations for collapsible and expansive soil

Reference Books:

1. N.P. Kurien, Design of Foundation Sytems, Principles & Practices, Narosa,
2. E.S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation, Taylor and Francis,
3. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis,
4. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers & Distributors,
5. P. C. Varghese, Foundation Design, PHI Learning Pvt. Ltd Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.
6. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press, 1999.
7. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 1994.
8. Poulos, H. G. and Davis, F. H., "Pile Foundation Analysis and Design", Wiley and Sons 1980, John Wiley & Sons, 1979.

Course Outcomes:

After Completion of course students will able to

CEP152.1 Describe various methods of soil explorations and select appropriate method for different projects and prepare soil investigation reports.

CEP152.2 Discuss different types of foundations and their suitability based on various criteria and different field situations.

CEP152.3 Select and design appropriate shallow and deep foundation based on subsurface investigation data and structural details.

CEP152.4 Determine foundation settlements based on soil properties and foundation details.

CEP153 GROUND IMPROVEMENT TECHNOLOGY

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Explain different issues related to problematic soils and their associated solutions.
II. Describe various methods of ground improvement, their principles and field applications.
III. Explain design techniques for ground improvement methods for different projects.

COURSE CONTENTS:

Introduction: Major soil deposits in India, Necessity of Ground Improvement, Various mechanisms of Ground Improvement, Classification, Applications, Economic consideration and suitability

Mechanical modification: Dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, Hydraulic modification: dewatering systems, preloading and vertical drains, electro-kinetic dewatering

Stone columns
Introduction, layout, function and application, advantages, vibrofloatation and rammed technique of stone column installation, Analysis of stone column treated soft soil, unit cell concept, load transfer mechanism, load carrying capacity and settlement analysis, different methods to improve the effectiveness of stone column, strengthening by micro piles

Chemical modification; Modification by admixtures, Methods of stabilization, mechanical stabilization, stabilization of soil using cement, lime, bitumen, chemical and fly ash stabilization, and stabilisation using industrial wastes,

Grouting – Applications, Types of grouts and their suitability, Desirable characteristics of grouts, Groutability
Grouting methods – Permeation grouting, soil facture grouting, Compaction grouting, Jet grouting, their applications
Grouting Technology- single stage grouting, Descending and Ascending stage grouting, Sleeved Pipe Grouting
Grout plant and equipment
Grouting procedure- Pre-grouting site investigation, Grout hole pattern, Grouting arrangement, Grout injection measurements and monitoring

Thermal modification: Ground freezing and thawing.

Soil reinforcement: Reinforced earth, basic mechanism, type of reinforcements, and selection of stabilisation/improvement of ground using Geotextiles, Geogrid, Geomembrane, geocells, genets, and soil nails.

Application of soil reinforcement: Shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, analysis and design of shallow foundations on reinforced earth, road designs with Geosynthetics

Reference Books:

1. Geotechnical Engineering, S K Gulhati& M Datta, Tat McGraw Hill Publishing Company Ltd. 2005
2. Ground Improvement Techniques, P Purushothams Raj, University Science Press, 2011.
3. Foundation Engineering Handbook, HSAI – YANG FANG, CHAPMAN & HILL, New York, 1991
4. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990.
5. Yonekura, R., Terashi, M. and Shibazaki, M. (Eds.), Grouting and Deep Mixing, A.A. Balkema, 1966.
6. Moseley, M.P., Ground Improvement, Blackie Academic & Professional, 1993.
7. Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., Ground Control and Improvement, John Wiley & Sons, 1994.
8. Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.
9. Shukla, S.K., Yin, Jian-Hua, "Fundamentals of Geosynthetic Engineering", Taylor & Francis.

Course Outcomes:

After Completion of course students will able to:

CEP153.1 Discuss different issues related to problematic soils and their associated solutions.

CEP153.2 Explain various methods of ground improvement, their principles, and applications in the field.

CEP153.3 Propose and design suitable ground improvement technique for different projects.

CEP154 PROGRAM ELECTIVE I

(A) EARTH DAM ANALYSIS & DESIGN

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Impart knowledge of design criteria, typical cross sections of earthen dams, design requirements of various components as per IS Code a to suit different field situations.

II. Preliminary design of earthen dams for the given data.

III. Carry out stability analysis of earthen dams

COURSE CONTENTS:

Preliminary section: Requirements of good dam, Types of earthen dams and their suitability, Components of earthen dam and their functions, Causes of failure, Design criteria, Typical cross sections as per and design requirements of various components as per IS Code, General guidelines for embankment section as per IS codes, Typical cross sections of earthen dams to suit different field conditions, suitability of different soils as per IS code

Stability analysis: Infinite and finite slopes with or without water pressures; concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method; Method of slices, Bishop's method,

Stability analysis in the presence of seepage: Two dimensional flow – Laplace equation and it's solution, graphical method, determination of phreatic line, flow nets in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, influence of seepage on slope stability, stability analysis of dam body during steady seepage,

Design of filters and upstream impermeable blanket

Stability analysis during earthquake: Stability analysis considering earthquake forces, Design considerations for earth dam in Seismic region.

Stability of foundation

Reference Books:

1. Engineering for Embankment Dams, Bharat Singh and R. S. Varshney, Oxford &IBH.
2. Irrigation Engineering, K. R. Arora, Standard Publishers Distributers.
3. Irrigation Engineering, R. K. Sharma and T. K. Sharma, S. Chnad& co., New Delhi, 2007

4. Mitchell, J.K and Soga, K., Fundamentals of Soil Behavior, John Wiley and Sons Inc., 2005.
5. Fang, H-Y., Introduction to Environmental Geotechnology, CRC Press,1997.
6. Daniel, D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.
7. Rowe, R.K., Quigley, R.M. and Booker, J.R., Clay Barrier Systems for Waste Disposal Facilities, E &FN Spon, 1995.
8. Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
9. Reddi, L.N. and Inyang, H.F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc, 2000.
10. Sharma, H.D. and Lewis, S.P, Waste Containment Systems, Waste Stabilization and
11. Landfills: Design and Evaluation, John Wiley & Sons Inc., 1994.

Course Outcomes:

After Completion of course students will able to

CEP154(A).1 Discuss the design criteria and design requirements of various components of earth dams as per revenant IS codes and draw typical cross sections of earthen dams to suit different field conditions.

CEP154 (A).2 Check the stability of earthen dams under different conditions.

CEP154 (A).3 Design the various components of earthen dam as per IS Codes of practice.

CEP154 PROGRAM ELECTIVE I
(B) COMPUTATIONAL GEOMECHANICS

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Provide knowledge of different numerical and statistical tools for analysing various geotechnical engineering problems and their suitability for different field situations.

II. Apply probabilistic approach for selection of design parameters and compute their impact on risk assessment.

COURSE CONTENTS:

Solution of Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods.

Solution of Linear Equations: Jacobi's method, Gauss Seidal method, Successive over relaxation method.

Finite Difference Method: Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.

Finite Element Method: Fundamentals, Constitutive finite element models for soils.

Correlation and Regression Analysis: Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

One-dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation.

Flow Through Porous Media - Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media.

Risk assessment in Geotechnical Engg. - Probabilistic site characterization and design of foundations.

Reference Books:

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.
3. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK.
4. Sam Helwany, "Applied soil mechanics", John Wiley & sons, Inc.

Course Outcomes:

After Completion of course students will able to:

CEP154(A).1 Describedifferent numerical and statistical tools for analysing various geotechnical engineering problems.

CEP154(B).2 Apply probabilistic approach for selection of design parameters and compute their impact on risk assessment

CEP154 PROGRAM ELECTIVE I
(C) DESIGN OF UNDERGROUND STRUCTURES

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Provide knowledge of planning and exploration for various underground construction projects, theirprinciples and its application in underground excavation design.
II. Provide basic concepts of elastic& plastic analysis,and rock mass classification systems in the design of underground support system.
III. Inculcate the importance of field tests generally conducted during and after construction of under structures.

COURSE CONTENTS:

I: Introduction, planning and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

II: Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen's theory.

IIII: Application of rock mass classification systems, ground conditions in tunnelling, analysis of underground openings in squeezing and swelling ground, empirical methods, estimation of elastic modulus and modulus of deformation of rocks; uniaxial jacking / plate jacking tests, radial jacking and Goodman jacking tests, long term behaviour of tunnels and caverns, New Austrian Tunnelling Method (NATM), Norwegian Tunnelling Method (NTM), Construction dewatering.

IV: Rock mass-tunnel support interaction analysis, ground response and support reaction curves, Ladanyi' selasto-plastic analysis of tunnels, design of various support systems including concrete and shotcrete linings, steel sets, rock bolting and rock anchoring, combined support systems, estimation of load carrying capacity of rock bolts.

V: In-situ stress, flat jack, hydraulic fracturing and over coring techniques and USBM type drill hole deformation gauge, single and multi-point bore hole extensometers, load cells, pressure cells, etc. Instrumentation and monitoring of underground excavations, during and after construction, various case studies

Reference Books:

1. Hoek, E and and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering.

2. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.
3. Singh, B. and Goel, R.K.,"Rock Mass Classification- A Practical Engineering Approach", Elsevier.
4. Singh, B. and Goel, R.K., "Tunnelling in Weak Rocks", Elsevier.

Course Outcomes:

After Completion of course students will able to:

CEP154(C).1 Carry out planning and exploration for various underground construction projects, their principles and its application in underground excavation design.

CEP154(C).2 Discuss elastic and plastic analysis and rock mass classification systemsin the design of underground support system.

CEP154(C).3 Explain field tests generally conducted during and after construction of under structures.

CEP155 GEOTECHNICAL ENGINEERING LAB I

Teaching Scheme: 06 P **Total = 06** **Credit : 03**
Evaluation Scheme: Internal = 50 **; External = 50** **Total Marks: 100**

Course Objectives:

I. Develop skills for conducting various laboratory tests as per relevant IS Codes to determine the various properties of soil.
II. Impart skills for conducting various field tests as per relevant IS Codes to determine the various insitu properties of soil.
III. Use Geo5 software for solving problems in Geotechnical Engineering.

COURSE CONTENTS:

A. List of Laboratory Practicals:

1. Collection of Undisturbed / Disturbed Sample for laboratory testing.
2. Determination of In-situ density and Specific gravity of soil.
3. Grain Size Distribution Analysis and Hydrometer Analysis.
4. Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit).
5. Visual Classification Tests.
6. Vibration test for relative density of sand.
7. Standard and modified proctor compaction test.
8. Falling head permeability test and Constant head permeability test.
9. Unconfined compression test.
10. Direct shear test.
11. Laboratory vane shear test.
12. Swelling Pressure Test.
13. Tri-axial compression test (Quick Test).
14. C. B. R. Test.
15. Consolidation test.

B. List of Field Practical's:

1. Field Vane shear test.
2. Standard penetration test.

3. Dynamic cone penetration test.
4. Static cone penetration test.
5. Plate load test.
6. Geophysical exploration tests.

C. Use of Geo5 Software for:

1. Determination of Earth pressure.
2. Determination of stability of retaining wall.
3. Determination of stability of slopes by various methods.
4. Design of shallow footing.
5. Design of pile foundation.
6. Determination of settlement of footing.

A Report based on above experiments shall be submitted by each student.

Course Outcomes:

After Completion of course students will able to:

CEP155.1 Perform various laboratory tests as per relevant IS Codes to determine the various physical, Index and engineering properties of soil.

CEP155.2 Perform various field tests as per relevant IS Codes to determine the various insitu properties of soil.

CEP155.3 Use Geo5 software for solving problems in Geotechnical Engineering.

CEP156 SEMINAR I

Teaching Scheme : 04 P Total =04 Credit : 02
Evaluation Scheme: Internal = 50 Total Marks: 50

Course Objectives:

I. Guide students to select a topic for seminar based on latest technological advancements and carry out literature review.

II. Guide students to prepare seminar report and power point presentation.

Seminar I: Student has to select a topic for Seminar based on literature review on advanced topics / recent developments in the field of Geotechnical Engineering and submit the report and deliver the seminar based on it. It is to be evaluated internally by panel of examiners headed by HOD (if possible) wherein guide should be one of the members of the panel.

Course Outcomes:

After Completion of course students will able to:

CEP156.1 Select a topic for seminar based on latest technological advancements and collect related literature.

CEP156.2 Prepare seminar report and power point presentation based on information collected related to the selected topic.

CEP156.3 Deliver seminar.

SEMESTER II

CEP251 DYNAMICS OF SOIL & FOUNDATIONS

Teaching Scheme : 03 L + 00 T Total = 03 Credits: 03
Evaluation Scheme: 10 TA +30 MSE + 60 ESE Total Marks: 100
Duration of ESE: 3 hrs.

Course Objectives:

I. Impart knowledge to identify principles of soil dynamics, theory of vibration, propagation of body waves and surface waves through soil.
II. Give insight in to different laboratory and field tests to determine dynamic soil properties required for design purpose.
III. Discussliquefaction mechanism and evaluation of liquefaction potentialstudies of various tests.
IV. Summaries general requirements of machine foundation, and criteria for its design.
V. Learn procedure of analysis & Design of different types of Machine foundation.

COURSE CONTENTS:

Introduction to dynamic loading:
Earthquake loading, machine vibrations, blast loading, background and lessons learnt from damages in past earthquakes due to soil and ground failure, effect of soil properties on seismic response of structures, seismic waves and their characteristics

Soil Dynamics and its applications

Fundamentals of vibrations: single, two and multiple degree of freedom systems, vibration isolation, vibration absorbers, vibration measuring instruments

Wave propagation: elastic continuum medium, semi-infinite elastic continuum medium, soil behaviour under dynamic loading.

Dynamic elastic constants of soil: Static and dynamic characteristics of soils, stress-strain behaviour of cyclically loaded soils, effect of strain level on the dynamic soil properties, measurement of seismic response of soil at low and high strain, using laboratory tests, cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - block vibration test, cross bore hole, their suitability and limitations, Interpretation of results, IS Codes

Liquefaction of soils: liquefaction mechanism, factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility, evaluation of liquefaction potentialstudies by dynamic tri-axial testing, oscillatory shear box, shake table and blast tests.

MACHINE FOUNDATION

Introduction: Types of machines, Types of machine foundations, Modes of vibrations, General requirements of machine foundation, General criteria for design, Permissible amplitude

Analysis & Design of Machine foundation: Elastic homogeneous half space and lumped parameter solutions, analysis and design of foundations for reciprocating and impact type machines, turbines, effect of machine foundation on adjoining structures.

Vibration isolation& control: Force isolation & motion isolation, Methods of isolation in machine foundations Isolating materials and their properties

Bearing capacity of foundations: Introduction to bearing capacity of dynamically loaded foundations

Reference Books:

1. Das, B.M., "Fundamentals of Soil Dynamics", Elsevier, 1983.
2. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson, 2008.
3. Prakash, S., Soil Dynamics, McGraw Hill, 1981.
4. Kameswara Rao, N.S.V., Vibration analysis and foundation dynamics, Wheeler Publication Ltd., 1998.
5. Richart, F.E. Hall J.R and Woods R.D., Vibrations of Soils and Foundations, Prentice Hall Inc., 1970.
6. Prakash, S. and Puri, V.K., Foundation for machines: Analysis and Design, John Wiley &
7. Sons, 1998Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.
8. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press, 1999.
9. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 1994.
10. Poulos, H. G. and Davis, F. H., "Pile Foundation Analysis and Design", Wiley and Sons 1980, John Wiley & Sons, 1979.

Course Outcomes:

After Completion of course students will able to:

CEP251.1 Explain basics of soil dynamics, theory of vibration, propagation of body waves and surface wavesthrough soil.

CEP251.2 Discuss different laboratory and field tests to determine dynamic soil properties required for design purpose.

CEP251.3 Describe liquefaction mechanism and evaluation of liquefaction potential studies by various tests.

CEP251.4 Explain general requirements of machine foundation, and criteria for its design.

CEP251.5 Analysis & Design of different types of Machine foundation required in the field.

CEP252 GEOTECHNICAL INVESTIGATIONS & CONSTRUCTION PRACTICES

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Provide knowledge of various methods of subsurface investigation and their suitability and preparation of reports.

II. Make students familiar with IS code provisions for subsurface investigations for civil engineering project.

III. Impart knowledge of construction methods, procedures and practices for stabilised rods, embankments, foundations and underground structures

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COURSE CONTENTS:

GEOTECHNICAL INVESTIGATIONS

Introduction
Planning of sub-surface programs, Stages in sub-surface exploration, Reconnaissance, Lateral extent and depth of exploration, Methods of exploration – trial pits, open excavation, boring etc.,

Types of boring and drilling
Auger, wash, rotary, percussion, core etc., Methods for stabilization of borehole, Types of soil samples, Sample disturbance, storage, labelling and transportation of samples

Types of soil samplers
Split spoon sampler, Scraper bucket sampler, Shelby tube and thin wall samplers, piston sampler, Denison sampler, hand carved samples etc.

Field Tests
Standard Penetration Test, Cone Penetration Test, Vane Shear Test, Plate Load Test, Pressure Meter Test, Geophysical methods, Seismic methods, Electrical resistivity methods. Determination of ground water table

Soil investigation report
Bore log, soil profile and contents of report, Field records

Site investigation in the view of ground improvement

GEOTECHNICAL CONSTRUCTION
Embankment construction: Earth moving equipment, Compaction equipment, types of rollers and their suitability, Methods of quality control, Compaction specifications
Construction of Rock fill dams

Deep Foundation Construction:

Piling- Pile driving methods, Pile driving equipment
Construction of Driven Precast concrete piles, Driven cast in situ concrete piles, Bored cast-in-situ concrete piles, under reamed piles, micro piles, Patented methods of pile construction

Excavation, Underground construction:
Underground construction Methodology, Vertical & Horizontal Construction, Management of ground water,
Excavate-support Sequence, Temporary & permanent Soil Support, Spoil removal, stabilisation of nearby foundations
Soil Support Methods
Dewatering Methods: Methods of Dewatering systems-open sumps and ditches, Well point systems, Deep-well drainage, Horizontal wells, Vacuum dewatering Systems, Dewatering by Electro-osmosis

Cofferdams
Caissons & Wells: Construction of open caisson, Pneumatic Caisson,
Construction of well foundation- Components and their functions, Different shapes, Sinking of Wells, Measures for rectification of tilt and shift
Constructional of machine foundations: Reinforcement and construction details

Tunnel: Cut and Cover tunnels, Bored tunnels: Shield Tunnels, Types of Shield tunnel machines, Tunnel lining and supports in Bored Tunneling, Jacked Tunnels: Box Jacking, Micro tunnels, Horizontal Directional Drilling,
Tunnel Boring machines (TBM) – Types of TBMs, Components of full face TBM, Choice between Full face and Partial face machines, Mucking

Construction of stabilised Roads- Construction of cement stabilised roads- different methods, Construction of Lime stabilised roads and bituminous stabilised roads, Field control of stabilization

Reference Books:

1. Geotechnical Engineering: S. K. Gulhati& M. Datta, Tata McGraw-Hill, New Delhi (2005)
2. Soil Mechanics and Foundation Engineering: K.R. Arora, Standard Publisher and Distributor
3. Soil Mechanics in Theory and Practice: Alam Singh, Asia Publisher and Distributor, (1975)
4. Basic and Applied soil mechanics: Gopal Ranjan & A.S. Rao, New Edge Int. ltd., (2004)
5. Advanced Foundation Engineering: Murthy VNS, CBS publishing, (2007)

Course Outcomes:
After Completion of course students will able to:
CEP252.1 Discussvarious methods of subsurface investigation and their suitability.

CEP252.2 Suggest and plan suitable methods of soil exploration based on the requirement of civil engineering project and site condition and prepare soil exploration report.

CEP252.3 Describeconstruction methods, procedures and practices for stabilised rods, embankments, foundations and underground structures.

CEP253 PAVEMENT ANALYSIS & DESIGN

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Describe Subsoil drainage and compaction of pavements.
II. Choose adequateDesign parameters and Material Characteristics for pavement analysis and design.
III. Perform analysis and Design of flexible pavements by various methods.
IV. Discuss analysis and Design of Rigid pavements by various methods.

COURSE CONTENTS:

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

Subsoil drainage in Highway: Design of filters, perforated pipe drainage, Methods of sub soil drainage for roads, permeable blankets, longitudinal and transverse under drains, horizontal drains, stabilizing trenches. Sub soil drainage in highways, runways and railways.

Compaction: Mechanics of compaction, Field-compaction equipment; their suitability and choice, Compaction quality control and measurement.

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 sub-grade soil classification. Group index, CBR, North Dakota cone bearing value, plate load test for "K", Marshal's method of bituminous mix design, Modulus of rupture and elasticity, poison's ratio &coefficient of thermal expansion of concrete, Layer equivalency concepts

Analysis of Flexible and Rigid Pavements: Stress, Strain deformation analysis for single, two, three and multi-layered flexible pavement systems. Stress and deflections for rigid pavements due to load and temperature, influence Charts, ultimate load analysis, joints in pavements.

Design of Flexible Pavement: Selection of pavement design input parameters – traffic loading and volume,failure criteria, Different methods -North Dakota cone, Group index, CBR, IRC-37, Brumister, Triaxial (Kansas), AASHO method of design, comparison of different pavement design approaches

Flexible Pavement Design for Airfields: U. S. Crops of Engineering, CBR, FAA, Mcload (Canadian)

Reference 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, 2001Yang and H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
7. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
8. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
9. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.)

Course Outcomes:

After Completion of course students will able to:

CEP253.1 Describe Subsoil drainage and compaction of pavements.

CEP253.2 Apply Design parameters and Material Characteristics for pavement analysis and design.

CEP253.3 Carry out analysis and Design of flexible pavements by various methods.

CEP253.4 Discuss analysis and Design of rigid pavements by various methods.

CEP254 PROGRAM ELECTIVE II

(A) GEOTECHNICAL EARTHQUAKE ENGINEERING

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Discuss causes and quantification of earthquake.
II. Study effect of earthquake and the design criterions to be followed for the design of different geotechnical structures.
III. Impart knowledge of Seismic design of foundations and Seismic slope stability analysis.

COURSE CONTENTS:

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

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

Ground response analysis – One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches, Computer code "SHAKE".

Liquefaction: Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.

Seismic design of foundations

Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls

Reference Books:

1. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson,2008.
2. Seco e Pinto, P., Seismic behaviour of ground and Geotechnical structure, A. A.
3. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.

4. Ferrito, J.M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities
5. service centre, Port Hueneme, 1997Highway Engineering; K. Khanna, and Justo, C.E.G., Khanna Publication, Roorkee, 2001Yang and H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
6. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
7. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
8. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.)

Course Outcomes:

After Completion of course students will able to:

CEP254(A).1 Describe the causes and quantification of earthquake.

CEP254(A).2 Discuss effect of earthquake and the design criterions to be followed for the design of different geotechnical structures.

CEP254(A).3 Describe Seismic design of foundations and Seismic slope stability analysis.

CEP254 PROGRAM ELECTIVE II

(B) ENVIRONMENTAL GEOTECHNOLOGY

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Recognize and describe sources and effects of subsurface contamination, characteristics of waste, and Soil-waste interaction,
II. Provide foundation for carrying outPlanning, designing and construction of landfills for MSW, and pond-ash.
III. Summarizeremediation and control of toxic and hazardous waste sites.
IV. Develop an understanding about Geotechnical re-use of waste materials.

COURSE CONTENTS:

Contamination: Surface & subsurface contamination, Sources and effects of subsurface contamination, Physical, Chemical and biological characteristics of solid waste, Identification, Characterization and regulatory requirements for disposal of hazardous, non-hazardous and domestic waste
Soil-waste interaction, Effect of pollutants on soil properties

Waste management: Recycling, Composting, Insiration, and various disposal methods, Site selection, Leachate collection and detection system

Contaminants of solid waste in landfills: Characteristics of solid wastes, Disposal of solid waste, Waste containment, Solid waste Landfills and its components, Shape and size of landfills, Types of landfills, Site selection Impervious barriers for liners and Covers, Liner systems and cover systems, , Landfill construction and operation, Leachate generation, Closure and post-closure care, Sustainable waste management, Ground water contamination associated with leachate transfer

Containment systems using Geomembrane: Advantages of using composite barrier for Liners and Covers, Single composite liner system for MSW landfill, Double composite liner system for HW landfill, Stability of landfills

Contaminants of slurry wastes: Slurry transported waste, Slurry Ponds and their operation, Embankment construction methods for ponds, Design aspects, Environmental impact and control,

Vertical barriers for containment: Contaminated sites, Types of vertical barriers, - Soil-bentonite slurry trench walls, and Cement-Bentonite slurry trench walls -construction and design aspects

Geotechnical reuse of Waste material: Waste reduction, Use of waste in Geotechnical construction, Waste characteristics for soil replacement, Transportation consideration, engineering properties of waste, Waste material in embankment and fills

Reclamation of contaminated site, various methods

Reference Books:

1. Mitchell, J.K and Soga, K., Fundamentals of Soil Behavior, John Wiley and Sons Inc., 2005.
2. Fang, H-Y., Introduction to Environmental Geotechnology, CRC Press, 1997.
3. Daniel, D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.
4. Rowe, R.K., Quigley, R.M. and Booker, J.R., Clay Barrier Systems for Waste Disposal Facilities, E & FN Spon, 1995.
5. Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
6. Reddi, L.N. and Inyang, H.F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc, 2000.
7. Sharma, H.D. and Lewis, S.P, Waste Containment Systems, Waste Stabilization and
8. Landfills: Design and Evaluation, John Wiley & Sons Inc., 1994.

Course Outcomes:

After Completion of course students will able to:

CEP254(B).1 Perceive and describe sources and effects of subsurface contamination, characteristics of waste, and Soil-waste interaction.

CEP254(B).2 Discuss Planning, designing and construction of landfills for MSW, and pond-ash.

CEP254(B).3 Explain remediation and control of toxic and hazardous waste sites.

CEP254(B).4 Relate knowledge of Environmental Geotechnology for Geotechnical re-use of waste materials.

CEP254 PROGRAM ELECTIVE II

(C) FOUNDATIONS ON WEAK SOIL

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Relate the knowledge of Engineering properties of weak rocks, different rock mass classification systems, Failure criteria for weak rocks and modes of failure of foundations on rocks/ rock masses.

II. Give deep insight in to bearing capacity and Pressure-settlement characteristics of foundations on rocks and rock masses.

III. Outline and describedesign procedure for different types of foundations placed over rock mass.

COURSE CONTENTS:

I: Engineering properties of weak rocks, different rock mass classification systems, relative merits and demerits

II: Failure criteria for weak rocks, bi-linear Mohr-Coulomb failure criterion, Hoek and Brown criterion and modified Hoek and Brown failure criterion etc.

III: Effect of structural planes on rock foundations, possible modes of failure of foundations on rocks/ rock masses, determination of in-situ shear strength of rocks and rock masses

IV: Requirements for satisfactory performance of foundations, bearing capacity of foundations on rocks and rock masses, allowable bearing pressure of rock foundations using a nonlinear failure criterion, monotonic and cyclic plate load tests

V: Pressure-settlement characteristics, effect of layering, anisotropy, heterogeneity and inelasticity

VI: Shallow foundations, shallow foundations on sloping ground, raft foundations, stilt foundations, foundations for suspension bridges, transmission line towers, framed buildings etc, treatment of foundations - open joints, solution cavities, weak seams

VII: Piles in weak rocks, bearing capacity and settlement of piles, piles in stratified rock masses, field load tests on piles in weak rocks, behaviour of bored / driven piles in soft / weathered rocks

Reference Books:

1. Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E&FNSpon, Taylor and Francis.
2. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford
3. Singh, B. and Goel, R.K., " Rock Mass Classification- A Practical Engineering Approach", Elsevier .
4. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd.
5. Hoek, E., "Practical Rock Engineering", Rock science.

Course Outcomes:

After Completion of course students will able to:

CEP254(C).1 Discuss Engineering properties of weak rocks,different rock mass classification systems, Failure criteria for weak rocks and modes of failure of foundations on rocks/ rock masses.

CEP254(C).2 Apply design procedure for different types of foundations placed over rock mass.

SHP221 RESEARCH METHODOLOGY

Teaching Scheme : 02 L + 00 T Total = 02 **Credits: 02**
Evaluation Scheme: 10 TA +30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 2 hrs.

Course Objectives:

I. Understand research problem formulation.

II. Analyze research related information

III. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

IV. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

COURSE CONTENTS:

Introduction to Research: Definition of research, Characteristics of research, Types of research- Descriptive *vs.* Analytical, Applied *vs.* Fundamental, Quantitative *vs.* Qualitative, Conceptual *vs.* Empirical, Steps of research methodology

Research Problem Formulation and Methods: Literature review, sources of literature, various referencing procedures, maintain literature data using Endnote2, Identifying the research areas from the literature review and research database, Problem Formulation, Identifying variables to be studied, determining the scope, objectives, limitations and or assumptions of the identified research problem, Justify basis for assumption, Formulate time plan for achieving targeted problem solution. Important steps in research methods: Observation and Facts, Laws and Theories, Development of Models. Developing a research plan: Exploration, Description, Diagnosis and Experimentation

Data collection: Sampling methods, methods of data collection, Basic Concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation Applied statistics: Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis Software tools for modeling, Simulation and analysis.

Research reports and Thesis writing: Introduction: Structure and components of scientific reports, types of report, Thesis writing: different steps and software tools in the design and preparation of thesis, layout, structure and language of typical reports, Illustrations and tables, bibliography, referencing and footnotes, Oral presentation: planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication.

Research Ethics, IPR and Publishing: Ethics: Ethical issues.
IPR: intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights

Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability.

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.
3. C.R. Kothari ,"Research Methodology: Methods and Trends", New Age International,2004
4. S.D. Sharma , "Operational Research", Kedar Nath Ram Nath & Co.,1972
5. B.L. Wadehra, "Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.

COURSE OUTCOMES:

At the end of this course, students will be able to

SHP221.1 Understand research problem formulation.

SHP221.2 Analyze research related information.

SHP221.3 Follow research ethics

SHP221.4 Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

SHP221.5 Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

CEP255 GEOTECHNICAL ENGINEERING LAB II

Teaching Scheme: 06 P **Total = 06** **Credit : 03**

Evaluation Scheme: Internal = 50; External = 50 Total Marks: 100

Course Objectives:

I. Develop skill for conducting laboratory tests to determine properties of stabilised / reinforced soil

II. Develop skill fordetermining the properties of Geosynthetics

III. Use Geo5 software for solving problems in Geotechnical Engineering

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COURSE CONTENTS:

Part A-List of Practical's:

1. UCS and C. B. R. test on cement and lime stabilized soil
2. Model plate load test on reinforced soil foundation bed
3. Tests on Geotextile and Geogrid to determine physical, Mechanical & survivability characteristics
4. Design earth dam and carry out its analysis

Part B: Designs

Design of earthen dam and its Seepage analysis and slope stability analysis, Design of filters

Part C: Geo5 Software

Use of Geo5 Software for Slope stability Analysis of Earthen dam for different conditions

Part D: Field Visits

Field visit should be arranged to soil investigation site, earth dam construction site, ground improvement site, stabilised road construction site or any other such site important from geotechnical engineering aspect.

A Report based on above experiments, Design and field visit reports shall be submitted by each student.

COURSE OUTCOMES:

After Completion of course students will able to:

CEP255.1 Execute the experiments to determine properties of stabilised / reinforced soil by conducting laboratory and field tests as per relevant IS Codes.

CEP255.2 Determine the various properties of Geosynthetics by conducting various lab tests as per relevant Codes.

CEP255.3 Use software for solving problems in Geotechnical Engineering.

CEP255.4 Design earth dam and carry out its analysis.

CEP255.5 Prepare visit report based on field visit.

CEP256 SEMINAR II

Teaching Scheme : 04 P **Total =04** **Credit : 02**
Evaluation Scheme: Internal = 50 **Total Marks: 50**

Course Objectives:

I. Guide students to select a topic for seminar based on latest technological advancements and carry out literature review, with a focus on selecting a topic for dissertation.

II. Guide students to prepare seminar report and power point presentation.

Seminar II: Student has to select a topic for Seminar based on literature review on advanced topics / recent developments in the field of Geotechnical Engineering and submit the report and deliver the seminar based on it. The topic for seminar should be related to the literature survey based on Dissertation topic. It is to be evaluated internally by panel of examiners headed by HOD (if possible) wherein guide should be one of the members of the panel.

Course Outcomes:

After Completion of course students will able to:

CEP256.1 Select a topic for seminar based on latest technological advancements and collect related literature.

CEP256.2 Prepare seminar report and power point presentation based on information collected related to the selected topic.

CEP256.3 Deliver seminar.

CEP351 PROGRAM ELECTIVE III

(A)FINITE ELEMENT METHOD IN GEOMECHANICS

Teaching Scheme : 03 L + 00 T Total= 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Develop theoretical background of finite element theory.

II. Impart knowledge of Finite Element Method for solution to different field problems such as settlement analysis, seepage analysis etc.

COURSE CONTENTS:

Stress-deformation analysis: One dimensional, Two dimensional and Three-dimensional formulations.

Discretization of a Continuum, Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions, Solution Algorithms.

Principles of discretization, element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence.

Displacement formulation: Rectangular, triangular and isoparametric elements for two dimensional and axisymmetric stress analysis.

Settlement Analysis: 2-D elastic solutions for homogeneous, isotropic medium,

Steady Seepage Analysis: Finite element solutions of Laplace's equation, Consolidation Analysis: Terzaghi consolidation problem, Choice of Soil Properties for Finite Element Analysis

Reference Books:

1. O.C. Zienkiewicz and R.L. Taylor, Finite element methods Vol I &Vol II, McGraw Hill, 1989,1992.
2. K.J. Bathe, Finite element procedures, PHI Ltd., 1996.
3. David M Potts and LidijaZdravkovic, "Finite Element Analysis in Geotechnical
4. Engineering Theory and Application", Thomas Telford. 1999.

Course Outcomes:

After Completion of course students will able to:

CEP351(A).1 Discuss fundamental theory of the FEA method and concepts behind variation methods and weighted residual methods in FEM.

CEP351(A).2 Develop element characteristic equation procedure and generation of global stiffness equation and apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.

CEP351(A).3 Perform engineering analysis for the given problem using FEM.

CEP351PROGRAM ELECTIVE III

(B) ENGINEERING ROCK MECHANICS

Teaching Scheme : 03 L + 00 T Total= 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Demonstrate and execute various laboratory tests on rock and classify rock mass.
II. Acquire knowledge of Strength Behavior and Strength/ Failure Criterion for rock masses.
III. Application of rock mechanics in Civil Engineering.

COURSE CONTENTS:

Rock: Formation of rocks, Physical properties, Classification of rocks and rock masses, Elastic constants of rock; Insitu stresses in rock

Rock Testing: Laboratory and Field tests

Rock Mass Classification Systems: Rock load classification according to Terzaghi, RQD index as a qualitative description of the rock mass, limitations and advantages, Lauffer-Pacher classification, Rock structure rating (RSR), Geomechanics Classification: General Comments on Application of Rock Mass Classification Schemes, Comparison of Rock Mass Classification Schemes

Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock

Strength Behaviour: Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior

Strength/ Failure Criterion: Mohr-Coulomb, Griffith theory, Hoek and Brown, strength and other strength criteria. Stresses in rock near underground openings;

Application of rock mechanics in Civil Engineering: Rock tunnelling, rock slope stability, bolting, blasting, grouting and rock foundation design. Modern modelling techniques & analyses in rocks

Reference Books:

1. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford
2. Goodman, R.E. Introduction to Rock Mechanics, John Wiley & Sons.
3. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd.
4. Jaeger, J.C. and Cook, N.G.W, Fundamentals of Rock Mechanics, Chapman and Hall,

Course Outcomes:

After Completion of course students will able to:

CEP351(B).1 Describe various laboratory tests on rock and rock massclassification.

CEP351(B).2 Discuss Strength Behaviour and Strength/ Failure Criterionfor rock masses and predict strength of rock mass with respect to various Civil Engineering applications.

CEP351(B).3 Apply principles of rock mechanics in Civil Engineering.

CEP351 PROGRAM ELECTIVE III

(C) EARTH RETAINING STRUCTURES

Teaching Scheme : 03 L + 00 T Total = 03 **Credits: 03**
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE **Total Marks: 100**
Duration of ESE: 3 hrs.

Course Objectives:

I. Stability analysis of different types of earth retaining structure

II. Design of different types of earth retaining structure

COURSE CONTENTS:

Earth Pressure: Rankin and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

Retaining walls: Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls.

Sheet Pile wall: Free earth system, fixed earth system.

Bulkheads: Bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates.

Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils.

Braced excavations: Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays.

Reference Books:

1. Das, Braja M., "Principles of Foundation Engineering", PWS Publishing. 1998
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.

Course Outcomes:

After Completion of course students will able to:

CEP351(C).1 Determine the earth pressure on retaining structures for different field situations.

CEP351(C).2 Design of different types of earth retaining Structures.

CEP351(C).3 Carry out stability analysis of retaining structures.

CEP352 DISSERTATION STAGE I

Teaching Scheme : 20 P Total =20 Credit : 10
Evaluation Scheme: Internal = 100 Total Marks: 100

Course Objectives:

I. Guide students to select a topic for dissertation based on latest technological advancements and carry out related literature review.

II. Guide students for development of a system to carry out analysis/experimental investigation for the selected area/problem.

Dissertation Stage I: Student has to select a topic for Project, carry out literature review, find the literature gap, carry out 25% or more work on Project topic and submit the report and deliver the seminar based on it. It is to be evaluated internally by three members panel of examiners headed by HOD (if possible) wherein guide should be one of the members of the panel.

Last date of submission of report shall be two weeks before the end of semester.

M.Tech Students opting for industrial dissertation for whole year will complete third semester courses through NPTEL or online courses as per the guidelines.

Course Outcomes:

After Completion of course students will able to:

CEP352.1 Select a topic for dissertation and carry out literature review for the selected topic.

CEP352.2 Develop a system to carry out analysis/experimental investigation for the selected area/problem.

CEP451 DISSERTATION STAGE II

Teaching Scheme : 06 P Total= 06 Credit : 16
Evaluation Scheme: Internal = 200; External = 200 Total Marks: 400

Course Objectives:

I. Guide students to carry out analysis/experimental investigation for the selected area/problemand derive conclusions based on results of investigations carried out.
II. Guide students to write dissertation report.
III. Prepare and deliver presentation.

Dissertation Stage II: Student has to carry out remaining project work on the selected Project topic and submit the report. It is to be evaluated internally by three members panel of examiners headed by HOD (if possible) wherein guide should be one of the members of the panel.

Course Outcomes:

After Completion of course students will able to:

CEP452.1 Carry out analysis/experimental investigation for the selected area/problemand derive conclusions based on results of investigations carried out.

CEP452.2 Write dissertation report.

CEP452.3 Prepare and deliver presentation.

SHP321 OPEN ELECTIVE

Teaching Scheme: 03L + 00 T Total = 03 Credit : 03
Evaluation Scheme: 10 TA + 30 MSE + 60 ESE Total Marks:100
Duration of ESE: 3 hrs.

(A) **BUSINESS ANALYTICS**

COURSE OBJECTIVES

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

COURSE CONTENTS

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

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

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

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trendsin : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

COURSE OUTCOMES:

At the end of the course, students shall be able to:

SHP321(A).1 Demonstrate knowledge of data analytics.

SHP321(A).2 Demonstrate the ability of think critically in making decisions based on data and deep analytics.

SHP321(A).3 Demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making.

SHP321(A).4 Demonstrate the ability to translate data into clear, actionable insights.

OPEN ELECTIVE
(B) INDUSTRIAL SAFETY

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

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

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

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

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

Reference:

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

OPEN ELECTIVE
(C) OPERATIONS RESEARCH

COURSE OBJECTIVES:

I. Apply the dynamic programming to solve problems of discreet and continuous variables.

II. Apply the concept of non-linear programming.

III. Carry out sensitivity analysis.

IV. Model the real-world problem and simulate it.

COURSE CONTENTS:

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

2: Formulation of anLPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

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

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

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

REFERENCES:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

COURSE OUTCOMES:

At the end of the course, the student should be able to:

SHP321(C).1 Apply the dynamic programming to solve problems of discreet and continuous variables.

SHP321(C).2 Apply the concept of non-linear programming.

SHP321(C).3 Carry out sensitivity analysis.

SHP321(C).4 Model the real-world problem and simulate it.

OPEN ELECTIVE
(D) COST MANAGEMENT OF ENGINEERING PROJECTS

Introduction: Overview of the Strategic Cost Management Process

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

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

Cost Behavior and Profit Planning: Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems, Standard Costing and Variance Analysis, Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector, Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets, Measurement of Divisional profitability pricing decisions including transfer pricing

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

REFERENCES:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OPEN ELECTIVE
(E) COMPOSITE MATERIALS

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

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

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

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

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

REFERENCES:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WDCallister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007
7. Hand Book of Composite Materials-ed-Lubin.
8. Composite Materials – K.K.Chawla.
9. Composite Materials Science and Applications – Deborah D.L. Chung.
10. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OPEN ELECTIVE
(F)WASTE TO ENERGY

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

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

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

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

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

REFERENCES:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OPEN ELECTIVE

(G) Finance Management (EE)

Offered by Electrical Engineering Department

OPEN ELECTIVE

(H) Project Management (EE)

Offered by Electrical Engineering Department

OPEN ELECTIVE

(I) Data Structure and Algorithms (CS)

Offered by Computer Science and Engineering Department

OPEN ELECTIVE

(H)Project Management (EE)

Offered by Electrical Engineering Department

SHP121 AUDIT COURSE

Teaching Scheme: 00L + 00 T Total = 00 Credit : 0
Evaluation Scheme: 00 TA + 00 MSE + 60 ESE Total Marks: 60
Duration of ESE: 3 hrs.

(A) ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES:

I. Understand that how to improve your writing skills and level of readability

II. Learn about what to write in each section

III. Understand the skills needed when writing a Title

IV. Ensure the good quality of paper at very first-time submission

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

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

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

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

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

Reference Books:

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

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(A).1 Understand that how to improve your writing skills and level of readability.

SHP121(A).2 Learn about what to write in each section.

SHP121(A).3 Understand the skills needed when writing a Title.

SHP121(A).4 Ensure the good quality of paper at very first-time submission.

(B) DISASTER MANAGEMENT

COURSE OBJECTIVES:

I. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

II. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

II. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

III. Critically understand the strengths and weaknesses of disaster management approaches,

IV. Planning and programming in different countries, particularly their home country or the countries they work in

COURSE CONTENTS:

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

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Manmade disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Disaster Prone Areas in India
Study of Seismic Zones; Areas Prone to Floods and Droughts,
Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports:
Governmental and Community Preparedness

Risk Assessment

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

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, EmergingTrendsin Mitigation. Structural Mitigation and Non-StructuralMitigation, Programs of Disaster Mitigation in India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep & Deep Publication Pvt. Ltd., New Delhi.

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(B). 1 Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

SHP121(B). 2 Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

SHP121(B). 3 Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

SHP121(B). 4 Critically understand the strengths and weaknesses of disaster management approaches,

SHP121(B). 5 Planning and programming in different countries, particularly their home country or the countries they work in

(C) **SANSKRIT FOR TECHNICAL KNOWLEDGE**

COURSE OBJECTIVES:

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

COURSE CONTENTS:

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

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

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

REFERENCES:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit
3. Sansthanam, New Delhi Publication
4. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(C).1 Underst basic Sanskrit language.

SHP121(C).2 know Ancient Sanskrit literature about science & technology.

SHP121(C).3 Develop logic.

(D) **VALUE EDUCATION**

COURSE OBJECTIVES:

I. Understand value of education and self- development.

II. Imbibe good values in students.

III. To know about the importance of character.

COURSE CONTENTS:

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

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

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

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

REFERENCES

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(D).1 Get Knowledge of self-development.

SHP121(D).2 Learn the importance of Human values.

SHP121(D).3 Develop the overall personality.

(E) **PEDAGOGY STUDIES**

COURSE OBJECTIVES:

I. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.

II. Identify critical evidence gaps to guide the development.

COURSE CONTENTS:

- Introduction and Methodology:
- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.
- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.
- Evidence on the effectiveness of pedagogical practices
- Methodology for the in-depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school?
- curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.
- Professional development: alignment with classroom practices and follow-up support
- Peer support
- Support from the head teacher and the community.
  Curriculum and assessment
- Barriers to learning: limited resources and large class sizes
- Research gaps and future directions
- Research design

- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

REFERENCES

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of
3. Curriculum Studies, 36 (3): 361-379.
4. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education
5. Research project (MUSTER) country report 1. London: DFID.
6. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of
7. Basic maths and reading in Africa: Does teacher preparation count? International Journal
8. Educational Development, 33 (3): 272–282. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.
9. Oxford and Boston: Blackwell.
10. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
11. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(E).1 Knows the pedagogical practices those are being used by teachers in formal and informal classrooms in developing countries.

SHP121(E).2 Know the effectiveness of pedagogical practices.

(F) **STRESS MANAGEMENT BY YOGA**

COURSE OBJECTIVES

I. To achieve overall health of body and mind

II. To overcome stress

COURSE CONTENTS

- Definitions of Eight parts of yog(Ashtanga)
- Yam and Niyam

Do`s and Don'ts's in life

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

- Asan and Pranayam

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

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

REFERENCES

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami YogabhyasiMandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(F).1 Develop healthy mind in a healthy body thus improving social health also.

SHP121(F).2 Improve efficiency.

(G) PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

COURSE OBJECTIVES:

I. To learn to achieve the highest goal happily.

II. To become a person with stable mind, pleasing personality and determination.

III. To awaken wisdom in students.

COURSE CONTENTS:

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)
- Approach to day to day work and duties
- ShrimadBhagwadGeeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.
- Statements of basic knowledge
- ShrimadBhagwadGeeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. ShrimadBhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

REFERENCES

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
3. Rashtriya Sanskrit Sansthanam, New Delhi.

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COURSE OUTCOMES:

At the end of the course, students will be able to:

SHP121(G).1 Develop personality and achieve the highest goal in life.

SHP121(G).2 Lead the nation and mankind to peace and prosperity.

SHP121(G).3 Develop versatile personality.