SCHOOL OF CIVIL AND CHEMICAL ENGINEERING

CURRICULUM

B. Tech. Civil Engineering

Breakup of Courses

Sl. No.	Category	Credits
1	University Core	70
2	University Elective	12
3	Programme Core	61
4	Programme Elective	37
	Minimum credits required to qualify	180
	Credits Offered	180

University Core Courses (70 Credits)

Course Code	Course Title	L	T	P	J	C	Pre requisites
CHY1002	Environmental Sciences	3	0	0	0	3	NONE
CHY1701	Engineering Chemistry	3	0	2	0	4	NONE
CLE3099	Industry Internship (II)	0	0	0	0	2	NONE
CLE3999	Technical Answers for Real World Problems (TARP)	1	0	0	8	3	PHY1999
CLE4098	Comprehensive Examination	0	0	0	0	2	NONE
CLE4099	Capstone Project	0	0	0	0	20	NONE
CSE1001	Problem Solving and Programming	0	0	6	0	3	NONE
CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3	NONE
ENG1011	English for Engineers	0	0	4	0	2	NONE
EXC4097	Co-Extra Curricular	0	0	0	0	2	NONE
FLC4097	Foreign Language Courses	2	0	0	0	2	NONE
HUM1021	Ethics and Values	2	0	0	0	2	NONE
MAT1011	Calculus for Engineers	3	0	2	0	4	NONE
MAT2001	Statistics for Engineers	3	0	2	0	4	MAT1011
MGT1022	Lean Start-up Management	1	0	0	4	2	NONE
PHY1701	Engineering Physics	3	0	2	0	4	NONE
PHY1999	Introduction to Innovative Projects	1	0	0	4	2	NONE
STS4097	Soft Skills (6 courses)	0	0	0	0	6	NONE
Total Credits						**70**	

University Elective: 12 Credits

Programme Core Courses (61 Credits)

S. No.	Course Code	Course Title	L	T	P	J	C	Pre requisites
1.	CLE1003	Surveying	3	0	2	4	5	MAT1011
2.	CLE1004	Soil Mechanics and Foundation Engineering	3	0	2	0	4	MAT1011
3.	CLE1006	Environmental Engineering	2	0	2	4	4	MAT1011
4.	CLE1007	Construction Materials and Techniques	3	0	0	0	3	NONE
5.	CLE2001	Building Drawing	1	0	2	4	3	CLE1007
6.	CLE2002	Strength of Materials	2	2	2	0	4	MEE1002
7.	CLE2003	Structural Analysis	2	2	0	0	3	CLE2002
8.	CLE2004	Water Resource Engineering	2	0	2	4	4	MEE1004
9.	CLE2005	Transportation Engineering	2	0	0	4	3	CLE1007
10.	CLE3001	Quantity Surveying and Estimating	2	0	0	0	2	CLE2001
11.	CLE3002	Basics of Structural Design	2	2	2	0	4	CLE2003
12.	MAT2002	Applications of Differential and difference equations	3	0	2	0	4	MAT1011
13.	MAT3003	Complex variables and Partial Differential Equations	3	2	0	0	4	MAT2002
14.	MAT3005	Applied Numerical Methods	3	2	0	0	4	MAT2002
15.	MEE1001	Engineering Drawing	1	0	4	0	3	NONE
16.	MEE1002	Engineering Mechanics	2	2	0	0	3	NONE
17.	MEE1004	Fluid Mechanics	2	2	2	0	4	NONE
		Total Credits					**61**	

Programme Electives (37 Credits):

Sl. No.	Course Code	Course Title	L	T	P	J	C	Pre requisites
1.	CLE1010	Natural Disaster Mitigation and Management	3	0	0	0	3	NONE
2.	CLE1011	Engineering Geology	2	0	0	0	2	NONE
3.	CLE1013	Environmental Impact Assessment	3	0	0	0	3	CHY1002
4.	CLE1016	Urban Planning	3	0	0	0	3	NONE
5.	CLE2007	Advanced Concrete Technology	3	0	2	4	5	CLE1007
6.	CLE2008	Construction Planning and Management	3	0	0	0	3	CLE1007
7.	CLE2009	Advanced Soil Mechanics	2	2	0	0	3	CLE1004
8.	CLE2010	Ground Improvement Techniques	2	0	0	4	3	CLE1004
9.	CLE2011	Soil Dynamics and Machine Foundation	2	2	0	0	3	CLE1004
10.	CLE2013	Advanced Foundation Engineering	2	2	0	0	3	CLE1004
11.	CLE2014	Geotechnical Earthquake Engineering	2	0	0	4	3	CLE1004
12.	CLE2015	Hydraulic Structures and Machinery	2	2	2	0	4	MEE1004
13.	CLE2017	Hydrology	3	0	0	0	3	MEE1004
14.	CLE2018	Industrial Wastes Treatment and Disposal	2	0	0	4	3	CLE1006
15.	CLE2019	Pollution Control and Monitoring	2	0	0	4	3	CLE1006
16.	CLE2020	Solid Waste Management	2	0	0	4	3	CLE1006
17.	CLE2022	Economics and Business Finance for Civil Engineers	3	0	0	0	3	CLE1007
18.	CLE2023	GIS and Remote Sensing	2	0	2	0	3	CLE1003
19.	CLE3004	Advanced Structural Analysis	2	2	2	0	4	CLE2003
20.	CLE3005	Ground Water Engineering	3	0	0	0	3	CLE2004
21.	CLE3007	Traffic Engineering	2	0	0	4	3	CLE2005
22.	CLE3008	Transport Planning and Management	2	0	0	4	3	CLE2005
23.	CLE3010	Architecture and Town Planning	2	0	0	4	3	CLE2001
24.	CLE3011	Finite Element Methods	2	2	0	0	3	CLE2003
25.	CLE4001	Design of Steel Structures	3	0	2	0	4	CLE3002
26.	CLE4002	Design of Advanced Concrete Structures	2	0	0	4	3	CLE3002
27.	CLE4003	Prestressed Concrete Design	3	0	0	0	3	CLE3002
28.	CLE4004	Seismic Design of Structures	2	2	0	0	3	CLE3002
29.	MEE1024	Operations Research	2	2	0	0	3	MAT2001

Course Code	ENVIRONMENTAL SCIENCES	L	T	P	J	C
CHY1002		3	0	0	0	3
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		1.1				

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implications of life style on the environment.
2. To understand the various causes for environmental degradation.
3. To understand individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome:

Students will be able to

1. Understand the need foreco-balance.
2. Acquire basic knowledge about global climate change with a particular reference to the Indian context.
3. Find ways to protect the environment and play pro-active roles

Student Learning Outcomes (SLO):	1,2,11

Module: 1	Environment and Ecosystem	7 hours	SLO: 1, 2

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module: 2	Biodiversity	6 hours	SLO: 1, 2

Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.

Module: 3	Sustaining Natural Resources and Environmental Quality	7 hours	SLO: 1, 2

Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.

Module: 4	Energy Resources	6 hours	SLO: 2, 11

Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar-Hydrogen revolution.

Module: 5	Environmental Impact Assessment	6 hours	SLO: 1, 2

Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.

Module: 6	Human Population Change and Environment	6 hours	SLO: 2,11

Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.

Module:7	Global Climatic Change and Mitigation	5 hours	SLO: 1,2

Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information

technology in environment-Case Studies.			
Module: 8	**Contemporary issues**	**2 hours**	
Lecture by Industry Experts			
Total Lecture hours		**45 hours**	
Text Books			
1.	G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.		
2.	George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.		
Reference Books			
1.	David M. Hassenzahl, Mary Catherine Hager, Linda R. Berg (2011), Visualizing Environmental Science, 4th Edition, John Wiley & Sons, USA.		
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	46th ACM	Date	24.08.17

Course Code	ENGINEERING CHEMISTRY	L	T	P	J	C
CHY1701		3	0	2	0	4
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		1.1				

Course Objectives:

- To impart technological aspects of applied chemistry
- To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcome:

- Students will be familiar with the water treatment, corrosion and its control, engineering applications of polymers, types of fuels and their applications, basic aspects of electrochemistry and electrochemical energy storage devices

Student Learning Outcomes (SLO):	1,2,14

Module: 1	Water Technology	5 hours	SLO: 1,14

Hardness of water - hardness causing impurities, pH, DO, TDS, COD and BOD in water; Estimation of hardness by EDTA method-numerical problems. Boiler troubles - scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion; Internal conditioning – Phosphate and calgon conditioning methods

Module: 2	Water Treatment	8 hours	SLO:1,14

Water treatment for Industrial purpose: External softening methods: Lime Soda process-numerical problems, Zeolite process and ion exchange including mixed bed ion exchange processes. Steps involved in treatment of water for municipal supply – Water purification for domestic purpose - Activated carbon filtration, UV treatment, Ozonolysis, Reverse osmosis.

Module: 3	Corrosion	6 hours	SLO: 2

Types and mechanism – dry and wet corrosion; Forms of corrosion [Differential aeration, pitting, Galvanic and stress corrosion cracking]; Factors affecting corrosion

Module: 4	Corrosion Control	4 hours	SLO: 2

Corrosion control methods: Inhibitors – anodic and cathodic and their action; Cathodic protection – sacrificial anodic and impressed current protection methods. Corrosion protection coatings: galvanizing and tinning; electroplating-processes and typical applications; Advanced coating processes – Basic concepts of PVD and CVD

Module: 5	Electrochemical Energy Systems	6 hours	SLO: 1,14

Basic concepts of cells and batteries-nominal voltage, operating voltage, capacity, self-discharge, depth of discharge, energy density, service life, shelf life. Working and applications of primary cells - Alkaline cells -and Li-primary cells.

Secondary cells and batteries - Ni-MH cells; Rechargeable lithium cells – chemistry and applications. Fuel cells – Electrochemistry of a H_2–O_2 fuel cell, Basics of solid oxide fuel cells-applications

Module: 6	Fuels and Combustion	8 hours	SLO: 2

Calorific value - Definition of LCV, HCV. Measurement of calorific value using bomb calorimeter and Boy's calorimeter including numerical problems. Combustion of fuels - minimum quantity of air by volume and by weight-Numerical problems. Knocking and chemical structure, octane number and cetane number and their importance; Biodiesel-synthesis, advantages and commercial applications

Module: 7	Polymers	6 hours	SLO: 2

Thermoplastic & Thermo setting resins – comparative properties. Properties and engineering applications of ABS, PVC, Teflon and Bakelite. Compression, injection, extrusion, Transfer moulding methods of plastics.

Conducting polymers: Intrinsic, extrinsic and doped polymers - Polyacetylene-mechanism of

conduction- Applications of conducting polymers in LEDs, Mobile phones			
Module: 8	**Contemporary issues:**	**2 hours**	
Lecture by Industry Experts			
Total Lecture hours		**45 hours**	

Text Book(s)

1.	Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015.
2.	O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015.
3.	B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008

Reference Books

1.	O.V. Roussak and H.D. Gesser, ***Applied Chemistry-A Text Book for Engineers and Technologists***, Springer Science Business Media, New York, 2nd Edition, 2013.
2.	S. S. Dara, ***A Text book of Engineering Chemistry,*** S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

List of Challenging Experiments (Indicative)	**SLO: 14**

	Experiment title	**Hours**
1.	Estimation of Dissolved Oxygen by Winkler's Method	1 h 50 min
2.	Softening of Water through Zeolite Resin – Assessment of Total Hardness using EDTA Method	1 h 50 min
3.	Water Preservation through Smart Materials	1 h 50 min
4.	Construction and Working of an Electrochemical Cell	1 h 50 min
5.	Irrigation Water - Sulphate ion Analysis by Conductometry	1 h 50 min
6.	Estimation of Calcium Hardness in Water by Flame Photometry	1 h 50 min
7.	Estimation of Nickel in a Ni-plated Material for Corrosion Protection by Colorimetry	1 h 50 min
8.	Analysis of Iron in Steel by Potentiometric Method	1 h 50 min
9.	Determination of Aromatic Content in Diesel by Aniline Point Measurement	1 h 50 min
10.	Engineering Polymers - Viscosity and Molecular Weight Analysis	1 h 50 min
11.	Lab Scale Production of Biodiesel from Plant Seeds (demo experiment)	3 hours
Total Laboratory Hours		**18 hours**

Mode of Evaluation: Viva-voce and Lab performance & FAT

Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	46th ACM	Date	24.08.17

Course Code	Technical Answers for Real World Problems (TARP)	L	T	P	J	C
CLE3999		1	0	0	8	3
Pre-requisite	PHY1999 and 115 Credits Earned	Syllabus version				
		1.0				

Course Objectives:

- To help students to identify the need for developing newer technologies for industrial / societal needs
- To train students to propose and implement relevant technology for the development of the prototypes / products
- To make the students learn to the use the methodologies available for analysing the developed prototypes / products

Expected Course Outcome:

- The students would have learnt the intricacies involved in problem identification and would have develop the art of using relevant technology for product development

Student Learning Outcomes (SLO):	5, 6, 17

Module: 1		2 hours	SLO: 5, 6, 17

Steps involved:

1. Strategies to identify the societal and industrial problems that need to be solved
2. SWOC analysis of the available technologies to overcome the problem
3. Possible technology revolution in the next 5 – 10 years
4. Analysis of the problems of present and future
5. Challenges in sustainable prototype / product development
6. Design of specific workflow in developing the prototype / product
7. Validation of the developed prototype / product
8. Analysis of the prototype/product with respect to social, economical, environmental relevance

(The proposed contact hours are for discussion on the projects)
(Projects to be done by a group of 6 – 10 students)

Student Learning Outcomes:

5. Having design thinking capability
6. Having an ability to design a component or a product applying all the relevant standards and with realistic constraints
17. Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice

Mode of Evaluation: (No FAT) Continuous Assessment the project done – Mark weightage of 20:30:50 – project report to be submitted.

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	ENGLISH FOR ENGINEERS	L	T	P	J	C
ENG1011		0	0	4	0	2
Pre-requisite	Cleared English Proficiency Test (EPT)/ Effective English	Syllabus version 2.2				

Course Objective:

- To enable students listen, speak, read and write effectively for academic purposes and face real-life situations

Expected Course Outcome:

- Facilitate students to communicate effectively in academic and social contexts

Student Learning Outcomes (SLO): 16, 18

Module: 1	**Listening**	**4 hours**	**SLO: 16**
Casual and Academic			
Module: 2	**Speaking**	**4 hours**	**SLO: 16**
Socializing Skills - Introducing Oneself- His / Her Goals & SWOT			
Module: 3	**Reading**	**2 hours**	**SLO: 16**
Skimming and Scanning			
Module: 4	**Writing**	**2 hours**	**SLO: 16**
Error-free sentences, Paragraphs			
Module: 5	**Listening**	**4 hours**	**SLO: 18**
News (Authentic Material): Analyzing General and Domain Specific Information			
Module: 6	**Speaking**	**4 hours**	**SLO: 16, 18**
Group Discussion on factual, controversial and abstract issues			
Module: 7	**Reading**	**2 hours**	**SLO: 16**
Extensive Reading			
Module:8	**Writing**	**2 hours**	**SLO: 16**
Email Etiquette with focus on Content and Audience			
Module: 9	**Listening**	**4 hours**	**SLO: 16**
Speeches : General and Domain Specific Information			
Module:10	**Speaking**	**4 hours**	**SLO: 16, 18**
Developing Persuasive Skills - Turncoat and Debate			
Module: 11	**Reading**	**2 hours**	**SLO: 16, 18**
Intensive Reading			
Module: 12	**Writing**	**2 hours**	**SLO: 16, 18**
Data Transcoding			
Module: 13	**Cross Cultural Communication**	**4 hours**	**SLO: 3, 16, 18**
Understanding Inter and Cross-Cultural Communication Nuances			
Module: 14	**Speaking**	**4 hours**	**SLO: 16, 18**
Public Speaking/Extempore /Monologues			

Module: 15	**Reading for research**	**2 hours**	**SLO: 16, 18**
Reading Scientific/Technical Articles			
Module: 16	**Writing**	**2 hours**	**SLO: 16, 18**
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)			
Module: 17	**Speaking**	**4 hours**	**SLO: 16, 18**
Mock Job/Placement Interviews			
Module: 18	**Writing**	**2 hours**	**SLO: 16, 18**
Report Writing			
Module: 19	**Speaking**	**4 hours**	**SLO: 16, 18**
Presentation using Digital Tools			
Module: 20	**Vocabulary**	**2 hours**	**SLO: 16, 18**
Crossword Puzzles/Word games			
Total Lecture hours		**60 hours**	

Text Book(s)

1. Clive Oxenden and Christina Latham-Koenig, New English File: Advanced: Teacher's Book with Test and Assessment CD-ROM: Six-level general English course for adults Paperback – Feb 2013, Oxford University Press, UK
2. Clive Oxenden and Christina Latham-Koenig, New English File: Advanced Students Book Paperback – Feb 2012, Oxford University Press, UK
3. Michael Vince, Language Practice for Advanced - Students Book, Feb. 2014, 4th Edition, Macmillan Education, Oxford, United Kingdom

Reference Books

1. Steven Brown, Dorolyn Smith, Active Listening 3, 2011, 3rd Edition, Cambridge University Press, UK
2. Tony Lynch, Study Listening, 2013, 2nd Edition, Cambridge University Press, UK
3. Liz Hamp-Lyons, Ben Heasley, Study Writing, 2010, 2nd Edition, Cambridge University Press, UK
4. Kenneth Anderson, Joan Maclean, Tony Lynch, Study Speaking, 2013, 2nd Edition, Cambridge University Press, UK
5. Eric H. Glendinning, Beverly Holmstrom, Study Reading, 2012, 2nd Edition Cambridge University Press, UK
6. Michael Swan, Practical English Usage (Practical English Usage), Jun 2017, 4th edition, Oxford University Press, UK
7. Michael McCarthy, Felicity O'Dell, English Vocabulary in Use Advanced (South Asian Edition), May 2015, Cambridge University Press, UK
8. Michael Swan, Catherine Walter, Oxford English Grammar Course Advanced, Feb 2012, 4th Edition, Oxford University Press, UK
9. Heather Silyn-Roberts, Writing for Science and Engineering: Papers, Presentations and Reports, Jun 2016, 2nd Edition, Butterworth-Heinemann, UK

Mode of Evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

List of Challenging Experiments (Indicative)		**SLO: 16, 18**
1.	Create a Digital or Online Profile or a Digital Footprint	6 hours
2.	Prepare a video resume	8 hours
3.	Analyse a documentary critically	4 hours
4.	Turn Coat- Speaking for and against the topic /	6 hours

	Activities through VIT Community Radio	
5.	Present a topic using 'Prezi'	6 hours
6.	Analyse a case on cross cultural communication critically	6 hours
7.	Create a list of words relating to your domain	4 hours
8.	Listen to a conversation of native speakers of English and answer the following questions	6 hours
9.	Read an article and critically analyse the text in about 150 words	6 hours
10.	Read an autobiography and role play the character in class by taking an excerpt from the book	8 hours
Total Practical Hours		**60 hours**

Mode of evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class / Virtual Presentations, Report and beyond the classroom activities			
Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	46th ACM	Date	24-08-2017

EXCXXXX **I -ALL CHAPTERS / TECHNICAL CLUBS** **L T P C- - - 2**

Objectives:

- To create a platform for students to be updated in the latest developments in respective fields
- To conduct various events/symposium/workshops/conferences
- To aid in sharpening the management & leadership skills by organizing events

Expected Outcomes:

- The students will be technologically updated
- Students shall improve their communication and management skills.
- Develop networking capacity with professionals

Mode of Evaluation:

Sl. No.	Activity	No. of hours	Marks	SLO
1	Regular Sessions: Participation in Weekly / Monthly Training, Guest Lecture & Internal competitions	20	20	16
2	Participation in Technical Competitions / Seminars / Workshops / Symposium / Conferences	15	20	13,16
3	Project Work: Working Models / Paper Presentation	15	20	16
4	Organizing / Volunteering during the conduct of internal activities of Club and Chapter	15	20	13,18
5	Participating / Organizing / Volunteering during Gravitas / Riviera and Intra Club and Chapter activities	10	10	18
6	Outreach activities / Industrial Visit / Field Visit	10	5	10
7	Final Report	5	5	
	TOTAL	**90**	**100**	

EXCXXXX **II - SOCIAL AWARENESS / OUTREACH CLUBS** **L T P C- - - 2**

Objectives:

- To provide the students with an opportunity to develop and contribute individually and collectively, as responsible members of the local / national / international community.
- To develop skills as a project organizer, time manager and team leader
- To learn how teamwork, cooperation and collaboration can bring changes to society
- To network with public / community developers

Expected Outcomes:

- The students will be able to lead through service
- Students will develop their skills in community service
- Develop networking capacity

Mode of Evaluation:

Sl. No.	Activity	No. of hours	Marks	SLO
1	Regular Sessions: Participation in Weekly / Monthly Training, Guest Lecture & Internal competitions	20	20	16
2	Participation in Social activity / Awareness Programmes / Workshops	15	20	13,16
3	Team work: Training sessions / Social development / organizing skills etc.,	15	20	16
4	Organizing / Volunteering during the conduct of internal activities of Club and Chapter	15	20	13,18
5	Participating / Organizing / Volunteering during Gravitas / Riviera and Intra Club and Chapter activities	10	10	18
6	Outreach activities / Field Visit	10	5	10
7	Final Report	5	5	
	TOTAL	**90**	**100**	

EXCXXXX	III – Sports and Cultural Clubs	L T P C- - - 2

Objectives:

- To create a platform for improving their talent in respective fields
- To build a network in showcasing skills & talents
- To help students to improve their organizational skills by conducting and coordinating events

Expected Outcomes:

- Students improve their skills in respective areas
- Students shall improve their leadership and management skills.
- Develop networking capacity

Mode of Evaluation:

Sl. No.	Activity	No. of hours	Marks	SLO
1	Regular Sessions: Participation in Weekly / Monthly Training, Guest Lecture & Internal competitions	20	20	16
2	Participation in Cultural Competitions / Lectures / Workshops	15	20	13,16
3	Team building activity: Training and organizing skills	15	20	16
4	Organizing / Volunteering during the conduct of internal activities of Club and Chapter	15	20	13,18
5	Participating / Organizing / Volunteering during Gravitas / Riviera and Intra Club and Chapter activities	10	10	18
6	Outreach activities / Field Visit	10	5	10
7	Final Report	5	5	16
	TOTAL	**90**	**100**	

Course Code	FRANÇAIS QUOTIDIEN (BASIC FRENCH)	L	T	P	J	C
FRE1001		2	0	0	0	2

Pre-requisite	NIL	Syllabus version
Anti-requisite	NIL	1.0

Course Objectives:

- This course is designed to introduce French through a study of Language with special focus on the cultural aspects.

Expected Course Outcome:

- Having interest in lifelong learning.
- Having adaptive thinking and adaptability.
- Having a good working knowledge of communicating in French
- Having critical thinking and innovative skills

Student Learning Outcomes (SLO):	11,12,16,18

Module: 1		3 hours	SLO: 11,12

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les PronomsSujets, Les PronomsToniques, La conjugaison des verbesirréguliers- avoir / être / aller / venir / faire etc.
Savoir-faire pour:
Saluer, Se présenter, Présenterquelqu'un, Etablir des contacts

Module: 2		3 hours	SLO: 11,12

La conjugaison des verbesréguliers, La conjugaison des verbespronominaux, La Négation, L'interrogation avec 'Est-cequeou sans Est-ceque'.
Savoir-faire pour:
Chercherun(e) correspondant(e), Demander des nouvellesd'unepersonne.

Module: 3		6 hours	SLO: 11,12

La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'articlecontracté, Les heures en français, L'adjectif (La Couleur, L'adjectifpossessif, L'adjectifdémonstratif/ L'adjectifinterrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.
Savoir-faire pour:
Poser des questions, Dire la date et les heures en français,

Module: 4		4 hours	SLO: 11,12

La traduction simple :(français-anglais / anglais –français),
Savoir-faire pour :
Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.

Module: 5		5 hours	SLO: 11,12,16

L'articlePartitif, Mettez les phrases aux pluriels, Faitesune phrase avec les mots donnés, Trouvez les questions.
Savoir-faire pour :
Répondez aux questions générales en français, Exprimez les phrases données au Masculinou au Féminin, Associez les phrases.

Module: 6		3 hours	SLO: 11,12,16

Décrivez :
La Famille / La Maison / L'université /Les Loisirs/ La Vie quotidienne etc.

Module: 7		4 hours	SLO: 11,12,16,18

Dialogue

a) Décrireunepersonne.

b) Des conversations à la cafeteria. c) Des conversations avec les membres de la famille d) Des dialogues entre les amis.			
Module: 8	**Contemporary Discussion**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)	
1	Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010.
2	Fréquence jeunes-1, Cahier d'exercices, G. Capelle et N.Gidon, Hachette, Paris, 2010.
Reference Books	
1	CONNEXIONS 1, Méthode de français, RégineMérieux, Yves Loiseau, Les Éditions Didier, Paris 2010.
2	CONNEXIONS 1, Le cahier d'exercices, RégineMérieux, Yves Loiseau, Les Éditions Didier, Paris 2010.
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, BéatrixSampsonis, Monique, Waendendries, Hachette livre Paris 2011
4	ALTER EGO 1, Le cahier d'activités, Annie Berthet, Catherine Hugo, BéatrixSampsonis, Monique Waendendries , Hachette livre, Paris 2011

Recommended by Board of Studies	26.02.2016		
Approved by Academic Council	41st ACM	Date	17.06.2016

Course Code	GRUNDSTUFE DEUTSCH (Basic German)	L	T	P	J	C
GER1001		2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
Anti-requisite		1.0				

Course Objectives:

This course is designed to introduce German through a study of Language with special focus on the cultural aspects.

Expected Course Outcome:

- Having interest in lifelong learning.
- Having adaptive thinking and adaptability.
- Having a good working knowledge of communicating in German.
- Having critical thinking and innovative skills

Student Learning Outcomes (SLO): 11,12,16,18

Module: 1		3 hours	SLO: 11,12

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen,wohnen, lernen,Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel - Bestimmter- UnbestimmterArtikel)
Lernziel :
Sichvorstellen, GrundlegendesVerständnisvonDeutsch, Deutschland in Europa

Module: 2		3 hours	SLO: 11,12

KonjugationderVerben(regelmässig /unregelmässig),dasJahr- Monate, Jahreszeitenund die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eineMillion), Ja-/Nein- Frage, Imperativmit ,,Sie''
Lernziel:
Sätzeschreiben, überHobbys, Berufeerzählen, usw.

Module: 3		5 hours	SLO: 11,12

Possessivpronomen, Negation, Kasus (Bestimmter- UnbestimmterArtikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, GetränkeundEssen, Farben, Tiere
Lernziel :
SätzemitModalverben, VerwendungvonArtikel, AdjektivbeimVerb

Module: 4		4 hours	SLO: 11,12

Übersetzung: (Deutsch – Englisch / Englisch – Deutsch)
Lernziel :
Die Übungvon Grammatik undWortschatz

Module: 5		5 hours	SLO: 11,12

Leserverständnis. Mindmapmachen, Korrespondenz- Briefeund Email
Lernziel:
Übung der Sprache, Wortschatzbildung.

Module: 6		3 hours	SLO: 11,12,16

Aufsätze :
Die Familie, Bundesländer in Deutschland, EinFest in Deutschland,
Lernziel :
Aktiver, selbständigerGebrauch der Sprache

Module:7		5 hours	SLO: 11,12,16,18

Dialoge:
a) Gesprächemiteinem/einerFreund /Freundin.

b) GesprächebeimEinkaufen ; in einemSupermarkt ; in einerBuchhandlung ; c) in einemHotel - an der Rezeption ;einTerminbeimArzt. d) EinTelefongespräch ; Einladung–Abendessen			
Module: 8	**Contemporary issues / Native speaker**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)	
1.	Netzwerk Deutsch alsFremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-LangenscheidtVerlag, München : 2013
Reference Books	
1.	Lagun, HartmutAufderstrasse, Jutta Müller, Thomas Storz, 2012.
2.	Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin :2010
3.	Deutsche SprachlehrefürAusländer, Heinz Griesbach, Dora Schulz, 2013
4.	TangramAktuell-I, Maria-Rosa, SchoenherrTil, Max HueberVerlag, Muenchen :2012

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	41st ACM	Date	17.06.2016

Course Code ESP1001	ESPAÑOL FUNDAMENTAL (Fundamental Spanish)	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	NIL	**Syllabus version**				
Anti-requisite	NIL	1.0				

Course Objectives:

This course is designed to introduce Spanish through a study of the Language with special focus on the cultural aspects.

Expected Course Outcome:

- Having interest in lifelong learning.
- Having adaptive thinking and adaptability.
- Having a good working knowledge of communicating in Spanish.
- Having critical thinking and innovative skills

Student Learning Outcomes (SLO):	**11,12,16,18**

Module: 1		**3 hours**	**SLO: 11,12**

Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión
Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero).
Competencia Escrita: Saludos y Datos personales

Module: 2		**3 hours**	**SLO: 11,12**

Edad y posesión. Números (1-20)
Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER.
Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase

Module: 3		**5 hours**	**SLO: 11,12**

Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas.
Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación

Module: 4		**4 hours**	**SLO: 11,12**

Mi familia. Números (21-100). Direcciones. Expresar la hora. Los meses del año.
Competencia Gramática: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR
Competencia Escrita: Mi familia. Dar opiniones sobre tiempo

Module: 5		**5 hours**	**SLO: 11,12**

Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares.
Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivos demostrativos.
Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a Ingles.

Module: 6		**3 hours**	**SLO: 11,12,16,18**

Describir el diario. Las actividades cotidianas.
Competencia Gramática: Los Verbos y pronombres reflexivos. Los verbos pronominales con e/ie, o/ue, e/i, u/ue.
Competencia Escrita: El horario. Traducción ingles a español y Español a Ingles.

Module: 7		**5 hours**	**SLO: 11,12,16,18**

Dar opiniones sobre comidas y bebidas. Decir lo que está haciendo.Describir mi ciudad y Ubicar los sitios en la ciudad.
Competencia Gramática: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo.
Competencia Escrita: Conversación en un restaurante. Traducción ingles a español y Español a

Ingles.Mi ciudad natal. Mi Universidad. La clase.Mi fiesta favorita.			
Module: 8	**Contemporary issues/ Native speaker**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)	
1.	Aula Internacional 1", Jaime Corpas, Eva Garcia, AgustinGarmendia, Carmen Soriano GoyalPublication ; reprintedEdition, (2010)
Reference Books	
1.	"¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006.
2.	"Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA, 2012.
3.	"Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
4.	"Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España , 2010

Recommended by Board of Studies	22.02.2016		
Approved by Academic Council	41st ACM	Date	17.06.2016

Course Code	RUSSIAN FOR BEGINNERS	L	T	P	J	C
RUS1001		2	0	0	0	2
Course Pre-requisites	NIL					
Objectives	To enable the students a. to read and communicate in Russian in their day to day life b. to become industry-ready					
Expected Outcome	The students will be able to read and communicate the basics of Russian language in their day to day life.					

Module	Topics	L Hrs	Text book pages	SLO
1	Greetings and introductions in Russian; Russian alphabet, writing and reading the Cyrillic alphabet. **The Students learn to:** Greet each other in Russian (formal vs. informal; depending of the time of the day). Introduce someone in Russian. Read and write Cyrillic alphabet	3	1-3	11,12
2	Basic phrases (yes/no, gratitude, apologies, saying hello/goodbye, etc.); Numbers (1-100); Days of the week, Months of the year; Seasons. Gender of nouns, hard and soft stems, and exceptions. **The Students learn to:** Have a simple conversation. Know numbers, days of the week, months and seasons.	3	4-6	11,12
3	Family (family members and pets). Learn Russian names: last name, first name, and patronymic. House and apartment. Parts of the body and health. Personal pronouns; *ты* vs. *вы*. Asking *Whose* in Russian? The Possessive pronouns. Asking *What* and *Who* in Russian? Nominative case. Asking *Where*? Prepositional case. The Country and Nationality. Prepositions (in/at/on/with etc.). The adjectives (colors, age, appearance, etc.). **The Students learn to:** Ask questions and demonstrate basic ability to communicate in Russian.	6	7-13	11,12
4	Shopping. Food. Clothes. Demonstrative pronouns *э mom* and *mom*. Dative case of personal pronouns, impersonal constructions. Simple translation (Russian-English-Russian). **The Students learn to:** Do shopping. Understand a short text in Russian.	4	14-17	11,12
5	Travelling. At the airport. Public transportation. Directions. Weather. Form a sentence with the given word. Place the sentences into plural form. Formulate questions. **The Students learn to:** Formulate and answer general questions in Russian. Express sentences given in Male or Female, Ask about and find a destination.	5	18-22	11,12, 16
6	Studying and Teaching. Profession. About myself. **The Students learn to:** Be able to tell about themselves (family, university, house, leisure, etc.)	3	23-25	11,12, 16
7	**Dialogues:** a) At the airport. a) In a cafeteria, grocery store, farmer's market, etc. c) About family d) Between friends.	4	29	11,12, 16,18
8	**Guest Lectures / native speakers**	2		11,12, 16,18
Total Lecture Hours		**30**		

Text Books:
1. Langenscheidt's Universal Russian Dictionary.

2. Russian Language Lessons. http://www.russianlessons.net/;
3. Russian for Everyone. http://www.russianforeveryone.com/
4. Teacher-generated PowerPoint slides and Handouts; Quizzes, Exercises and Games in class and online.

Reference Books:

Syllabus Proposed by: Prof. Irina Trubetskova, VIT University, Vellore-632014.

Course Code	ETHICS AND VALUES	L	T	P	J	C
HUM1021		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				

Course Objectives:

- To inculcate moral values and ethical standards in students

Expected Course Outcome:

- Ability to follow sound morals and ethical values scrupulously to prove as good citizens

Student Learning Outcomes (SLO):	2, 10, 11, 12		
Module: 1	**Being good and responsible**	**5 hours**	**SLO: 2, 11**
Gandhian values such as truth and non-violence – comparative analysis on leaders of past and present – society's interests versus self-interests			
Personal Social Responsibility: Helping the needy, charity and serving the society.			
Module: 2	**Social Issues 1**	**4 hours**	**SLO: 2, 11**
Harassment – types - Prevention of harassment, violence and terrorism			
Module: 3	**Social Issues 2**	**4 hours**	**SLO: 2, 11**
Corruption: ethical values, causes, impact, laws, prevention – electoral malpractices			
white collar crimes - tax evasions – unfair trade practices			
Module: 4	**Addiction and Health**	**3 hours**	**SLO: 10, 12**
Peer pressure - Alcoholism: ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides			
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases			
Module: 5	**Drug Abuse**	**4 hours**	**SLO: 10, 12**
Abuse of different types of legal and illegal drugs: ethical values, causes, impact, laws and prevention			
Module: 6	**Personal and Professional Ethics**	**3 hours**	**SLO: 10, 11**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism			
Module: 7	**Abuse of technologies**	**4 hours**	**SLO: 2, 10**
Hacking and other cyber crimes, addiction to mobile phone usage, video games and social networking websites			
Module: 8	**Invited Talk:** Contemporary Issues	**3 hours**	**SLO: 2, 12**
Total Lecture hours		**30 hours**	

Reference Books

1.	Dhaliwal, K.K (2016), "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts, Writers Choice, New Delhi, India
2.	Vittal, N (2012), "Ending Corruption? - How to Clean up India?", Penguin Publishers, UK
3.	Birch, S (2011), "Electoral Malpractice", Oxford University Press, UK
4.	Pagliaro, L.A. and Pagliaro, A.M (2012), "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological , Developmental and Clinical Considerations", Wiley Publishers, U.S.A
5.	Pandey, P. K (2012), "Sexual Harassment and Law in India", Lambert Publishers, Germany

Mode of Evaluation: Quizzes, CAT, Digital assignments, poster/collage making and projects

Recommended by Board of Studies	26-07-2017		
Approved by Academic Council	No. xx	Date	DD-MM-YYYY

Course Code	CALCULUS FOR ENGINEERS	L	T	P	J	C
MAT1011		3	0	2	0	4
Pre-requisite	10+2 Mathematics or MAT1001	Syllabus Version				
		1.0				

Course Objectives:

- To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
- To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus are introduced.
- To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Expected Course Outcome

At the end of this course the students are expected to learn

- how to apply single integrals to find the area and volume by using the techniques of definite integrals and improper integrals
- how to find the maxima and minima for functions involving single or several variables
- how to evaluate multiple integrals in Cartesian, Cylindrical and Spherical geometries.
- the powerful language of Vector calculus with physical understanding to deal with subjects such as Fluid Dynamics and Electromagnetic fields.
- use of Laplace Transform Techniques in Signal analysis

Student Learning Outcomes (SLO):	**1,2,9**

Module:1	**Applications of Single Variable Differentiation and Integration**	**9 hours**	**SLO:** 1,2

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution - Beta and Gamma functions–interrelation

Module: 2	**Laplace transforms**	**7 hours**	**SLO:** 1,9

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module: 3	**Multivariable Calculus**	**4 hours**	**SLO:** 1,2

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and it Prosperities.

Module: 4	**Applications of Multivariable Calculus**	**5 hours**	**SLO:** 1,9

Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.

Module: 5	**Multiple integrals**	**8 hours**	**SLO:** 2,9

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates- - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- -evaluation of multiple integrals using gamma and beta functions.

Module: 6	**Vector Differentiation**	**5 hours**	**SLO:** 1,9

Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems

Module: 7	**Vector Integration**	**5 hours**	**SLO:** 2,9

line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems - verification and evaluation of vector integrals using them.

Module: 8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
Total Lecture hours		**45 hours**	

Text Book(s)

1. Thomas' Calculus by George B. Thomas, D. Weir and J. Hass, 13th edition 2014, Pearson.
2. Advanced Engineering Mathematics by Erwin Kreyszig, 10th Edition, John Wiley India, 2015

Reference Books

1. Higher Engineering Mathematics by B.S. Grewal, 43rd Edition ,Khanna Publishers, India,2015
2. Higher Engineering Mathematics by John Bird, 5th Edition, Elsevier Limited, 2006.
3. Calculus: Early Transcendentals by James Stewart, 8th edition, Cengage Learning, 2014.
4. K.A.Stroud and Dexter J. Booth, Engineering Mathematics, 6th Edition, Palgrave Macmillan (2007)

Mode of Evaluation: Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		**SLO:** 1, 2, 9
1.	Introduction to MATLAB through matrices, and general Syntaxes,	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating Maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Greens theorem to real world problems	2 hours
Total Laboratory Hours		**24 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test

Recommended by Board of Studies	25.02.2017		
Approved by Academic Council	45th ACM	Date	16.03.2017

Course Code	STATISTICS FOR ENGINEERS	L	T	P	J	C
MAT2001		3	0	2	0	4
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus Version				
		1.0				

Course Objectives:

- To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
- To analyse distributions and relationships of real-time data.
- To apply estimation and testing methods to make inference and modeling techniques for decision making.

Expected Course Outcome

At the end of this course the students are expected to

- Have an understanding of the probability concepts.
- Analyze the problems connected with statistics and reliability.
- Understand how to make the transition from a real problem to a probability model for that problem. The most desirable is to expose students to practical applications of expectation and probability that provide the proper tools for handling the design of the system that involve randomness.

Student Learning Outcomes (SLO):	1,2,7

Module: 1	Introduction to Statistics	6 hours	SLO: 2,7

Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].

Module: 2	Random variables	8 hours	SLO: 1,7

Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.

Module: 3	Correlation and regression	4 hours	SLO: 2,7

Correlation and Regression – Partial and Multiple correlation- Multiple regression.

Module: 4	Probability Distributions	7 hours	SLO: 1,7

Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution

Module: 5	Hypothesis Testing I	4 hours	SLO: 2,7

Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis- Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.

Module: 6	Hypothesis Testing II	9 hours	SLO: 1,7

Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.

Module: 7	Reliability	5 hours	SLO: 2,7

Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.

Module: 8	Contemporary Issues	2 hours	

Industry Expert Lecture

Total Lecture hours	**45 hours**	

Text Book(s)

1. Probability and Statistics for engineers and scientists by R.E.Walpole, R.H.Mayers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
2. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, (2016), John Wiley & Sons; 6th Edition.

Reference Books

1. Reliability Engineering by E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2010.
2. Probability and Statistics by J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
3. Probability and Statistics for Engineers by R.A.Johnson, Miller & Freund's, 8th edition, Prentice Hall India (2011)
4. Probability, Statistics and Reliability for Engineers and Scientists by Bilal M. Ayub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Challenging Experiments (Indicative)		**SLO:** 1, 2, 7
1.	Introduction: Understanding Data types; importing/exporting data.	2 hours
2	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination	2 hours
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination	2 hours
5.	Fitting the following probability distributions: Binomial distribution,	2 hours
6.	Normal distribution Poisson distribution	2 hours
7.	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours
8.	Testing of hypothesis for Two sample mean and proportion from real-time problems	2 hours
9.	Applying the t test for independent and dependent samples	2 hours
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours
Total Laboratory Hours		**22 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test

Recommended by Board of Studies	25.02.2017		
Approved by Academic Council	45th ACM	Date	16.03.2017

Course Code	LEAN START-UP MANAGEMENT	L	T	P	J	C
MGT1022		1	0	0	4	2
Pre-requisite	NIL	Syllabus Version				
		1.00				

Module	Topics	Hours	SLO
1	Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)	2	4, 19
2	Minimum Viable Product (Value Proposition, Customer Segments, Build-measure-learn process)	3	2, 4
3	Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model-templates)	3	18,19
4	Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of	3	2, 4
5	Legal, Regulatory, CSR, Standards, Taxes	2	18, 19
6	Lectures by Entrepreneurs	2	2
Total Lecture Hours		**15**	

Teaching: Modes:
Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks

Text Books

1. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Steve Blank, K & S Ranch; 1st edition (March 1, 2012)
2. The Four Steps to the Epiphany, Steve Blank, K&S Ranch; 2nd edition (July 17, 2013)
3. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically

Reference Books

1. Holding a Cat by the Tail, Steve Blank, K&S Ranch Publishing LLC (August 14, 2014)
2. Product Design and Development, Karal T Ulrich, SD Eppinger, McGraw Hill
3. Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business; (16 September 2014)
4. Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), Alistair Croll & Benjamin oskovitz, O'Reilly Media; 1st Edition (March 21, 2013)

1. Inspired: How To Create Products Customers Love, Marty Cagan, SVPG Press; 1st edition (June 18, 2008)

Website References

1. http://theleanstartup.com/
2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries 3. http://businessmodelgeneration.com/
4. https://www.leanstartupmachine.com/
5. https://www.youtube.com/watch?v=fEvKo90qBns
6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref 7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms
8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/
9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything
10. https://hbr.org/2016/03/lean-strategy&cm_sp=Article-_-Links-_-End%20of%20Page%20Recirculation 11.https://hbr.org/2013/05/in-big-companies-lean-is-only
12.https://hbr.org/2016/03/start-ups-that-last
13.http://www.nen.org/blog/the-lean-paradigm/

Date of approval by the Academic Council : 25.08.2016

Course Code	ENGINEERING PHYSICS	L	T	P	J	C
PHY1701	Engineering Physics	3	0	2	0	4
Pre-requisite	Physics of 12th standard or equivalent	Syllabus version				
		1.1				

Course Objectives:

1. Having an ability to apply mathematics and science in engineering applications [SLO 1]
2. Having a clear understanding of the subject related concepts and of contemporary issues [SLO 2]
3. Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified) [SLO 4]

Expected Course Outcome:

Students will acquire the necessary knowledge about modern physics and its applications in various engineering and technology disciplines.This course meets the following student outcomes

- an ability to apply knowledge of physics in engineering problems
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to identify, formulate, and solve engineering problems

Student Learning Outcomes (SLO):	1,2,4

Module: 1	Introduction to Modern Physics	6 hours	SLO: 1,2

Planck's concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module: 2	Applications of Quantum Physics	5 hours	SLO: 1, 2

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative) (AB 205), Scanning Tunneling Microscope (STM).

Module: 3	Nanophysics	5 hours	SLO: 1

Introduction to Nano-materials, Moore's law, Properties of Nano-materials, Quantum confinement, Quantum well, wire & dot, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module: 4	Laser Principles and Engineering Application	6 hours	SLO: 1,2

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO2 and Dye laser and their engineering applications.

Module: 5	Electromagnetic Theory and its application	6 hours	SLO: 2,4

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index , Wave guide (Qualitative)

Module: 6	Propagation of EM waves in Optical fibers	6 hours	SLO: 1

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal.

Module: 7	Optoelectronic Devices & Applications of Optical fibers	9 hours	SLO: 2,4

Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.

Special Theory of Relativity:

Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.

Module: 8	Contemporary issues	2 hours	

Lecture by Industry Experts

Total Lecture hours	45 hours	

Text Book(s)	
1.	Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2.	William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3.	D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4.	Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson.
Reference Books	
1.	Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2.	John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3.	Kenneth Krane Modern Physics, 2010, Wiley Indian Edition.
4.	Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI Learning Private Ltd.
6.	S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
7.	R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
8.	Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
9.	Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.
Mode of Evaluation: Quizzes , Digital Assignments, CAT-I and II and FAT	

List of Challenging Experiments (Indicative)		**SLO: 14,17**
1.	Determination of Planck's constant using electroluminescence process (Module 1)	2 hours
2.	Electron diffraction (Module 1)	2 hours
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique (Module 4)	2 hours
4.	Dispersive power of prism (Module 6)	2 hours
5.	Optical Fiber communication (source + optical fiber + detector) (Modules 7+8)	2 hours
6.	Determination of size of fine particle using laser diffraction (Module 3)	2 hours
7.	Determination of the track width (periodicity) in a written CD (Module 4)	2 hours
8.	PIN diode characteristics (Module 8)	2 hours
9.	Black body Radiation (Module 1+2)	2 hours
10.	Optical Fiber communication (source + optical fiber + detector) (Modules 7 + 8)	2 hours
11.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction (Module 3)	2 hours
12.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (Module 2) (can be given as an assignment)	2 hours
13.	Laser coherence length measurement (Module 4)	2 hours
14.	Proof for transverse nature of E.M. waves (Module 6)	2 hours
15.	Quantum confinement and Heisenberg's uncertainty principle (Module 1 + 3)	2 hours
Total Laboratory Hours		**30 hours**

Recommended by Board of Studies	11.08.2017		
Approved by Academic Council	No.	Date	

Course Code	INTRODUCTION TO SOFT SKILLS	L	T	P	J	C
STS1001		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

- Having a clear understanding of professional and ethical responsibility[SLO 10]
- Having adaptive thinking and adaptability[SLO 12]

Expected Course Outcome:

- Enabling students to know themselves and interact better with self and environment

Student Learning Outcomes (SLO): 10,12

Module: 1	Lessons on excellence	10 hours	SLO:10

Ethics and integrity
Importance of ethics in life, Intuitionism vs Consequentialism, Non-consequentialism, Virtue ethics vs situation ethics, Integrity - listen to conscience, Stand up for what is right
Change management
Who moved my cheese?, Tolerance of change and uncertainty, Joining the bandwagon, Adapting change for growth - overcoming inhibition
How to pick up skills faster?
Knowledge vs skill, Skill introspection, Skill acquisition, "10,000 hours rule" and the converse
Habit formation
Know your habits, How habits work? - The scientific approach, How habits work? - The psychological approach, Habits and professional success, "The Habit Loop", Domino effect, Unlearning a bad habit
Analytic and research skills.
Focused and targeted information seeking, How to make Google work for you, Data assimilation

Module: 2	Team skills	11 hours	SLO:10

Goal setting
SMART goals, Action plans, Obstacles -Failure management
Motivation
Rewards and other motivational factors, Maslow's hierarchy of needs, Internal and external motivation
Facilitation
Planning and sequencing, Challenge by choice, Full Value Contract (FVC), Experiential learning cycle, Facilitating the Debrief
Introspection
Identify your USP, Recognize your strengths and weakness, Nurture strengths, Fixing weakness, Overcoming your complex, Confidence building
Trust and collaboration
Virtual Team building, Flexibility, Delegating, Shouldering responsibilities

Module: 3	Emotional Intelligence	12 hours	SLO:12

Transactional Analysis
Introduction**,** Contracting, Ego states**,** Life positions
Brain storming
Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming
Psychometric Analysis
Skill Test, Personality Test
Rebus Puzzles/Problem Solving
More than one answer, Unique ways

Module:4	Adaptability	12 hours	SLO:12
Theatrix Motion Picture, Drama, Role Play, Different kinds of expressions **Creative expression** Writing, Graphic Arts, Music, Art and Dance **Flexibility of thought** The 5'P' framework (Profiling, prioritizing, problem analysis, problem solving, planning) **Adapt to changes(tolerance of change and uncertainty)** Adaptability Curve , Survivor syndrome			
Total Lecture hours		**45 hours**	

Text Book(s)	
1.	Chip Heath, How to Change Things When Change Is Hard (Hardcover**)**, 2010, First Edition, Crown Business.
2.	Karen Kindrachuk, Introspection**,** 2010, 1st Edition.
3.	Karen Hough, The Improvisation Edge: Secrets to Building Trust and Radical Collaboration at Work, 2011, Berrett-Koehler Publishers

Reference Books	
1.	Gideon Mellenbergh, A Conceptual Introduction to Psychometrics: Development, Analysis and Application of Psychological and Educational Tests, 2011, Boom Eleven International.
2.	Phil Lapworth, An Introduction to Transactional Analysis, 2011, Sage Publications (CA)

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	45th ACM	Date	15.06.2017

Course Code	INTRODUCTION TO BUSINESS COMMUNICATION	L	T	P	J	C
STS1002		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

- Having problem solving ability- solving social issues and engineering problems [SLO 9]
- Having interest in lifelong learning [SLO 11]

Expected Course Outcome:

- Enabling students enhance knowledge of relevant topics and evaluate the information

Student Learning Outcomes (SLO): 9, 11

Module: 1	Study skills	10 hours	SLO: 9

Memory techniques
Relation between memory and brain, Story line technique, Learning by mistake, Image-name association, Sharing knowledge, Visualization
Concept map
Mind Map, Algorithm Mapping, Top down and Bottom Up Approach
Time management skills
Prioritization - Time Busters, Procrastination, Scheduling, Multitasking, Monitoring
6. Working under pressure and adhering to deadlines

Module: 2	Emotional Intelligence (Self Esteem)	6 hours	SLO: 9

Empathy
Affective Empathy and Cognitive Empathy
Sympathy
Level of sympathy (Spatial proximity, Social Proximity, Compassion fatigue)

Module: 3	Business Etiquette	9 hours	SLO: 9, 11

Social and Cultural Etiquette
Value, Manners, Customs, Language, Tradition
Writing Company Blogs
Building a blog, Developing brand message, FAQs', Assessing Competition
Internal Communications
Open and objective Communication, Two way dialogue, Understanding the audience
Planning
Identifying, Gathering Information, Analysis, Determining, Selecting plan, Progress check, Types of planning
Writing press release and meeting notes
Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph, Body – Make it relevant to your audience

Module: 4	Quantitative Ability	4 hours	SLO: 9

Numeracy concepts
Fractions, Decimals, Bodmas, Simplifications, HCF, LCM, Tests of divisibility
Beginning to Think without Ink
Problems solving using techniques such as: Percentage, Proportionality, Support of answer choices, Substitution of convenient values, Bottom-up approach etc.
Math Magic
Puzzles and brain teasers involving mathematical concepts
Speed Calculations
Square roots, Cube roots, Squaring numbers, Vedic maths techniques

Module: 5	Reasoning Ability	3 hours	SLO: 9
Interpreting Diagramming and sequencing information Picture analogy, Odd picture, Picture sequence, Picture formation, Mirror image and water image **Logical Links** Logic based questions-based on numbers and alphabets			
Module:6	**Verbal Ability**	**3 hours**	**SLO: 11**
S**trengthening Grammar Fundamentals** Parts of speech, Tenses, Verbs(Gerunds and infinitives) **Reinforcements of Grammar concepts** Subject Verb Agreement, Active and Passive Voice, Reported Speech			
Module: 7	**Communication and Attitude**	**10 hours**	**SLO: 11**
Writing Writing formal & informal letters, How to write a blog & knowing the format, Effective ways of writing a blog, How to write an articles & knowing the format, Effective ways of writing an articles, Designing a brochures **Speaking skills** How to present a JAM, Public speaking **Self managing** Concepts of self management and self motivation, Greet and Know, Choice of words, Giving feedback, Taking criticism			
Total Lecture hours		**45 hours**	

Text Book(s)	
1.	FACE, Aptipedia, Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt. Ltd.

Reference Books	
1.	Alan Bond and Nancy Schuman, 300+ Successful Business Letters for All Occasions, 2010, Third Edition, Barron's Educational Series, New York.
2.	Josh Kaufman, The First 20 Hours: How to Learn Anything ... Fast, 2014, First Edition, Penguin Books, USA.

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	45th ACM	Date	15.06.2017

Course Code	REASONING SKILL ENHANCEMENT	L	T	P	J	C
STS2001		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

- Having problem solving ability- solving social issues and engineering problems [SLO 9]
- Having adaptive thinking and adaptability [SLO 12]

Expected Course Outcome:

- Understanding the various strategies of conflict resolution among peers and supervisors and respond appropriately

Student Learning Outcomes (SLO): 9,12

Module: 1	Social Interaction and Social Media	6 hours	SLO: 9

Effective use of social media
Types of social media, Moderating personal information, Social media for job/profession, Communicating diplomatically
Networking on social media
Maximizing network with social media, How to advertise on social media
Event management
Event management methods, Effective techniques for better event management
Influencing
How to win friends and influence people, Building relationships, Persistence and resilience, Tools for talking when stakes are high
Conflict resolution
Definition and strategies , Styles of conflict resolution

Module: 2	Non Verbal Communication	6 hours	SLO:12

Proximecs
Types of proximecs**,** Rapport building
Reports and Data Transcoding
Types of reports
Negotiation Skill
Effective negotiation strategies
Conflict Resolution
Types of conflicts

Module: 3	Interpersonal Skill	8 hours	SLO:12

Social Interaction
Interpersonal Communication, Peer Communication, Bonding, Types of social interaction
Responsibility
Types of responsibilities**,** Moral and personal responsibilities
Networking
Competition, Collaboration, Content sharing
Personal Branding
Image Building, Grooming, Using social media for branding
Delegation and compliance
Assignment and responsibility, Grant of authority, Creation of accountability

Module: 4	Quantitative Ability	10 hours	SLO: 9

Number properties
Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position
Averages
Averages, Weighted Average

Progressions Arithmetic Progression, Geometric Progression, Harmonic Progression **Percentages** Increase & Decrease or successive increase **Ratios** Types of ratios and proportions			
Module: 5	**Reasoning Ability**	**8 hours**	**SLO:9**
Analytical Reasoning Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzletest, Selection Decision table			
Module: 6	**Verbal Ability**	**7 hours**	**SLO:9**
Vocabulary Building Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies			
Total Lecture hours		**45 hours**	

Text Book(s)	
1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt.Ltd.
3.	Mark G. Frank, David Matsumoto, Hyi Sung Hwang, Nonverbal Communication: Science and Applications, 2012, 1st Edition, Sage Publications, New York.
Reference Books	
1.	Arun Sharma, Quantitative aptitude, 2016, 7th edition, Mcgraw Hill Education Pvt. Ltd.
2.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler, Crucial Conversations: Tools for Talking When Stakes are High, 2001, 1st edition McGraw Hill Contemporary, Bangalore.
3.	Dale Carnegie, How to Win Friends and Influence People, Latest Edition, 2016. Gallery Books, New York.

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies			
Approved by Academic Council	45th ACM	Date	15.06.2017

Course Code	INTRODUCTION TO ETIQUETTE	L	T	P	J	C
STS2002		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

- Having cross cultural competency exhibited by working in teams. [SLO 13]
- Having critical thinking and innovative skills. [SLO 18]

Expected Course Outcome:

Creating in the students an understanding of decision making models and generating alternatives using appropriate expressions.

Student Learning Outcomes (SLO):	13,18

Module: 1	Impression Management	8 hours	SLO: 13

Types and techniques
Importance of impression management, Types of impression management, Techniques and case studies,Making a good first impression in an interview (TEDOS technique) , How to recover from a bad impressions/experience, Making a good first impression online
Non-verbal communication and body language
Dressing, Appearance and Grooming, Facial expression and Gestures, Body language (Kinesics), Keywords to be used, Voice elements (tone, pitch and pace)

Module: 2	Thinking Skills	4 hours	SLO:18

Introduction to problem solving process
Steps to solve the problem, Simplex process **Introduction to decision making and decision making process** Steps involved from identification to implementation**,** Decision making model

Module: 3	Beyond Structure	4 hours	SLO:13

Art of questioning
How to frame questions, Blooms questioning pyramid, Purpose of questions
Etiquette
Business, Telephone etiquette, Cafeteria etiquette, Elevator etiquette, Email etiquette, Social media etiquette

Module: 4	Quantitative Ability	9 hours	SLO: 18

Profit and Loss
Cost Price & Selling Price, Margins & Markup
Interest Calculations
Simple Interest, Compound Interest, Recurring
Mixtures and solutions
Ratio & Averages, Proportions
Time and Work
Pipes & Cisterns, Man Day concept, Division Wages
Time Speed and Distance
Average speed, Relative speed, Boats and streams.
Proportions & Variations

Module: 5	Reasoning Ability	11 hours	SLO: 18

Logical Reasoning
Sequence and series, Coding and decoding, Directions **Visual Reasoning**
Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial reasoning, Cubes
Data Analysis And Interpretation
DI-Tables/Charts/Text

Module: 6	Verbal Ability	9 hours	SLO: 13
Grammar Spot the Errors, Sentence Correction, Gap Filling Exercise, Sentence Improvisations, Misc. Grammar Exercise			
Total Lecture hours		**45 hours**	
Text Book(s)			
1.	Micheal Kallet, Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills, April 7, 2014, 1st Edition, Wiley, New Jersey.		
2.	MK Sehgal, Business Communication, 2008, 1st Edition, Excel Books, India.		
3.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.		
4.	ETHNUS, Aptimithra, 2013, First edition, McGraw-Hill Education Pvt. Ltd, Banglore.		
Reference Books			
1.	Andrew J. DuBrin, Impression Management in the Workplace: Research, Theory and Practice, 2010, 1st edition, Routledge.		
2.	Arun Sharma, Manorama Sharma, Quantitative aptitude, 2016, 7th edition, McGraw Hill Education Pvt. Ltd, Banglore.		
3.	M. Neil Browne, Stuart M. Keeley, Asking the right questions, 2014, 11th Edition, Pearson, London.		
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	45th ACM	Date	15/06/2017

Course Code	PREPAREDNESS FOR EXTERNAL OPPORTUNITIES	L	T	P	J	C
STS3001		3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

- Having problem solving ability- solving social issues and engineering problems [SLO 9]
- Having critical thinking and innovative skills [SLO 18]

Expected Course Outcome:

- Enabling students acquire skills for preparing for interviews, presentations and higher education

Student Learning Outcomes (SLO): 9, 18

Module: 1	Interview Skills	3 hours	SLO: 9

Types of interview
Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview
Techniques to face remote interviews
Video interview, Recorded feedback , Phone interview preparation
Mock Interview
Tips to customize preparation for personal interview, Practice rounds

Module: 2	Resume Skills	2 hours	SLO: 18

Resume Template
Structure of a standard resume**,** Content, color, font
Use of power verbs
Introduction to Power verbs and Write up
Types of resume
Quiz on types of resume
Customizing resume
Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module: 3	Presentation Skills	6 hours	SLO: 18

Preparing presentation
10 tips to prepare PowerPoint presentation**,** Outlining the content, Passing the Elevator Test
Organizing materials
Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation
Maintaining and preparing visual aids
Importance and types of visual aids, Animation to captivate your audience, Design of posters
Dealing with questions
Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module: 4	Quantative Ability	14 hours	SLO: 9

Permutation-Combinations
Counting, Grouping, Linear Arrangement, Circular Arrangements
Probability
Conditional Probability, Independent and Dependent Events
Geometry and Mensuration
Properties of Polygon, 2D & 3D Figures, Area & Volumes
Trigonometry
Heights and distances, Simple trigonometric functions
Logarithms
Introduction, Basic rules

Functions Introduction, Basic rules **Quadratic Equations** Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations **Set Theory** Basic concepts of Venn Diagram			
Module: 5	**Reasoning Ability**	**7 hours**	**SLO: 18**
Logical reasoning Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic **Data Analysis and Interpretation** Data Sufficiency Data interpretation-Advanced Interpretation tables, pie charts & bar chats			
Module: 6	**Verbal Ability**	**8 hours**	**SLO: 18**
Comprehension and Logic Reading comprehension Para Jumbles Critical Reasoning : Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument			
Module: 7	**Writing Skills**	**5 hours**	**SLO: 9**
Note making What is note making, Different ways of note making **Report writing** What is report writing, How to write a report, Writing a report & work sheet **Product description** Designing a product, Understanding it's features, Writing a product description **Research paper** Research and its importance, Writing sample research paper			
Total Lecture hours		**45 hours**	
Text Book(s)			
1.	Michael Farra, Quick Resume & Cover letter Book, 2011, 1st Edition, JIST Editors, Saint Paul.		
2.	Daniel Flage, An Introduction to Critical Thinking, 2002, 1st Edition, Pearson, London.		
Reference Books			
1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.		
2.	ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt. Ltd.		
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies			
Approved by Academic Council	45th ACM	Date	15/06/2017

Course Code	SURVEYING	L	T	P	J	C
CLE1003		3	0	2	4	5
Pre-requisite	**MAT1011 Calculus for Engineers**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the basic principles of surveying and different methods of surveying
2. To learn about Tacheometry, geodetic surveying and GPS surveying
3. To know the types of errors encountered in different types of surveying

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Learn about basics involved in different types of surveying instruments.
2. Demonstrate skills in performing measurement of distance, angles, leveling, and curve setting.
3. Develop skills for estimating distance between given points, area of a given plot and earthwork involved in cuttings and fillings.
4. Develop skill to carry out tachometry, geodetic surveying wherever situation demands.
5. Develop skills to apply error adjustment to the recorded reading to get an accurate surveying output.

Student Learning Outcomes (SLO):	1, 9, 14, 17

Module: 1	**Measurements of Distance, Angles and Directions**	**6 hours**	**SLO: 1**
Importance of surveying - Classifications - principles, Chain and tape measurement – Meridians, Azimuths and bearings – compass - Theodolites – adjustments – Horizontal and Vertical angle measurements - Plane table surveying			
Module: 2	**Determination of Elevations**	**6 hours**	**SLO: 17**
Differential levelling, longitudinal & cross section levelling, refraction & curvature correction, reciprocal leveling			
Module: 3	**Determination of Distance and Elevations by Tacheometry**	**5 hours**	**SLO: 9, 17**
Tacheometry – Stadia tacheometry, tangential tacheometry& substance tacheometry and Contouring			
Module: 4	**Calculation of Area and Volume**	**6 hours**	**SLO: 1,17**
Area - Computation, measurements from cross section - volume calculation from spot levels, earth work calculations, practical problems			
Module: 5	**Curve Surveying**	**6 hours**	**SLO: 9, 17**
Definitions, designation of curve, elements of simple curve - settings of simple circular curve, compound and reverse curve- transition curve – Introduction to vertical curve			
Module: 6	**Modern Field Instruments**	**7 hours**	**SLO: 9, 17**
Electronic Distance Measurement - Basic Principle – Classifications -Electro-optical system - computing distances – Electronic Total Station instruments – Types – Measurements with total station - Surveying with Global Positioning Systems (GPS); Field data collection through remote sensing and Photogrammetry			
Module: 7	**Field Applications**	**7 hours**	**SLO: 17**
Preparation of Topographic Map- Contour Map - TIN model and Generation of 3D Surface - Preparation of Longitudinal & cross section of roads using Software			
Module: 8	**Contemporary issues**		
Total Lecture hours		**45 hours**	

Text Book(s)

1.	Surveying and Levelling, Vol. I &II, by B.C.Punmia, Laxmi Publications, 2016.

Reference Books

1.	Surveying Vol. I, II and III by Dr. K.R. Arora, Standard Book House. New Delhi Roy S.K. (2009),

	Fundamentals of Surveying, Prentice Hall of India		
2.	Surveying and Levelling, by R. 000Subramaniyan, Oxford University Press 2014.		
3.	Satheesh Gopi (2005) GPS Principles and Applications, Tata McGraw Hill publishing company Ltd.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory	L Hr	SLO
1. Calculate the area of a given parcel of land by cross staff survey using chain surveying 2. Find the two-dimensional coordinates of the survey points through traversing with prismatic compass and chain 3. Prepare the layout map of a given building using Plane Table Surveying 4. Horizontal & Vertical Angle measurement using Theodolite 5. Calculate the reduced level of points by rise and fall method and height of collimation method using dumpy level 6. Longitudinal and Cross Sectional leveling of a given road segment using dumpy level 7. Stadia tacheometry to find the distance and elevation 8. Tangential Tacheometry to find the distance and elevation 9. Setting out of a Simple Circular Curve 10. Contour map preparation using RLs calculated from staff readings of dumpy level 11. Distance and angular measurement and area calculation using total station.	**30**	**14**

Course Code	SOIL MECHANICS AND FOUNDATION ENGINEERING	L	T	P	J	C
CLE1004		3	0	2	0	4
Pre-requisite	**MAT1011 Calculus for Engineers**	**Syllabus version**				
		1.0				

Course Objectives:

1. To impart the fundamental concepts of soil mechanics and understand the bearing capacity
2. To understand the concept of compaction and consolidation of soils
3. To understand the design aspects of foundation
4. To evaluate the stress developed in the soil medium
5. To study the stability of slopes

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the properties for soil in foundation sites
2. Know the importance engineering properties such as Consolidation, Shear strength.
3. Know the Soil Investigation techniques and conduct the field test like SPT, PLT, DCPT
4. Find the safe bearing capacity of soil and calculate the Load carrying capacity of pile foundation

Student Learning Outcomes (SLO): 1, 2, 14

Module: 1	**Soil Properties and Compaction**	**7 hours**	**SLO: 1, 2, 14**

Basic definitions; Phase relations; Index properties; Grain size distribution & Index properties; Soil Classification (IS) Compaction, Laboratory compaction tests & Factors affecting compaction.

Module: 2	**Effective Stress Principle and Permeability**	**5 hours**	**SLO: 1, 2**

Principle of effective stress; Capillarity; Seepage force and quicksand condition One-dimensional flow; Darcy's law; Laboratory methods for permeability determination.

Module: 3	**Stress Distribution and Consolidation**	**7 hours**	**SLO: 1, 2**

Boussinesq stress distribution theory and Newmarks chart Compressibility of soils, e-p data and stress history; Normally consolidated and over-consolidated soils; Terzaghi's theory of one-dimensional consolidation; Time-rate of consolidation; Evaluation of compressibility and consolidation parameters.

Module: 4	**Shear Strength Behaviour**	**6 hours**	**SLO: 1, 2, 14**

Mohr's stress circle; Mohr-Coulomb failure criterion; Laboratory tests for shear strength determination; Effective and total stress shear strength parameters; Shear strength characteristics of clays and sands.

Module: 5	**Soil Exploration**	**4 hours**	**SLO: 2**

Objective of site investigation– Detailed site investigation – Methods of exploration – Depth of exploration – Factors governing location and depth of foundation – Types of Foundations – Selection of Foundation. Preparation of soil investigation report

Module: 6	**Bearing Capacity and Settlements of Shallow Foundations**	**8 hours**	**SLO:1, 2, 14**

Terzaghi's theory of bearing capacity – General and local shear failure - Effect of Water table – Plate load test – Standard Penetration Test – Design of Footings – Settlement of footings - Immediate and Time dependent settlement – Permissible limits of total and differential Settlement

Module: 7	**Pile Foundations and Slope Stability**	**6 hours**	**SLO: 2, 14**

Classification and selection of piles – Static and dynamic formulae for single pile capacity – Efficiency and capacity of pile groups – Design of Pile group – Settlement of Pile Groups– Load test on piles
Failure of infinite and finite slopes – Swedish circle method – Factor of safety - Slope stability of earth dams.
Definitions – Earth pressure at rest – Rankine's active and passive earth pressures - Coulomb's earth pressure theories – Types of retaining walls

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**45 hours**	

Text Book(s)			
1.	K.R.Arora, "Soil mechanics and Foundation Engineering" Std Publishers, New Delhi. 2011.		
Reference Books			
1.	Braja M. Das, "Principles of Geotechnical Engineering", Cengage learning pvt. Ltd, 8th Edition, 2014.		
2.	Holtz D. and Kovacs, W.D., "An Introduction to Geotechnical Engineering", Prentice Hall. 2nd Edition 2011.		
Mode of evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory Exercises	L Hrs	SLO
Determination of Specific Gravity	30	14
Grain size Analysis – Mechanical Method		
Consistency Limits i) Liquid Limit ii) Plastic Limit		
Relative density		
Compaction Test		
Determination of Field Density		
Coefficient of Permeability – Constant Head & falling head Method		
Direct Shear Test		
Unconfined compression Test		
Vane shear test		
Consolidation Test		
California Bearing Ratio Test		

Course Code	ENVIRONMENTAL ENGINEERING	L	T	P	J	C
CLE1006		2	0	2	4	4
Pre-requisite	**MAT1011 Calculus for Engineers**	**Syllabus version**				
		1.0				

Course Objectives:

1. To teach students the basic principles and concepts of unit operations and processes involved in water and wastewater treatment.
2. To develop a student's skill in the basic design of unit operations and processes involved in water and wastewater treatment.
3. To develop a student's skill in evaluating the performance of water and wastewater treatment plants.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Demonstrate an ability to recognize the type of unit operations and processes involved in water and wastewater treatment plants.
2. Recognize that water supply and sanitation is an important professional and ethical responsibility of civil and environmental engineer.
3. Demonstrate an ability to choose the appropriate unit operations and processes required for satisfactory treatment of water and wastewater.
4. Demonstrate an ability to design individual unit operation or process appropriate to the situation by applying physical, chemical, biological and engineering principles.
5. Involve in mega projects where water and wastewater treatments are essential.
6. Prepare the layout of water and wastewater treatment plants.
7. Demonstrate ability in monitoring of water and wastewater treatment plants.
8. Demonstrate ability in design of water and wastewater treatments units in a cost effective and sustainable way and evaluate its performance to meet the desired health and environment related goals.
9. Recognize the importance of wastewater treatment to protect the water resources which is facing a continuous degradation in water quality.

Student Learning Outcomes (SLO):	5, 9, 14		
Module: 1	**Introductions to water and wastewater treatment**	**3 hours**	**SLO:** 9, 14
Basics of water supply – Networks - forecasting methods. On site and centralized treatment systems, Water and wastewater quality parameters, Role of water and wastewater quality parameters and their standards			
Module: 2	**Water and wastewater quality enhancement**	**5 hours**	**SLO:** 5, 9
Unit operations and unit processes, Concept and application of mass balance in reactor design, Fundamentals of process kinetics			
Module: 3	**Physical treatment of surface water and groundwater**	**5 hours**	**SLO:** 5, 9
Sedimentation, filtration, adsorption and ion exchange, membrane			
Module: 4	**Chemical treatments of surface water and groundwater**	**4 hours**	**SLO:** 5, 9
Coagulation-flocculation; Chemical Softening; Chlorination; Oxidation			
Module: 5	**Pre-and primary treatment of wastewater**	**3 hours**	**SLO:** 5, 9
Process flow sheet; Screen, grit removal, oil and grease removal, primary sedimentation			
Module: 6	**Secondary Treatment of wastewater**	**6 hours**	**SLO:** 5, 9, 14
Activated sludge process, conventional and extended aeration, trickling filters and bio			
Module: 7	**Wastewater and Sludge Disposal**	**2 hours**	**SLO:** 9
Reuse systems, wastewater disposal on land and water bodies, and disposal of sludge			

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)	
1.	Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., "Environmental Engineering", McGraw Hill, 2013
Reference Books	
1.	Davis, M.L. and Cornwell, D.A., "Introduction to Environmental Engineering", McGraw Hill.,2013
2.	Masters, G.M., "Introduction to Environmental Engineering and Science", Prentice Hall of India, 2008
3.	Arcievala, S.J., "Wastewater Treatment for Pollution Control", Tata McGraw Hill., 2009
4.	Metcalf and Eddy , Wastewater Engineering, Treatment and reuse, Tata McGraw-Hill Edition, Fourth edition., 2007
5.	Hammer, M.J. and Hammer, M.J., "Water and Wastewater Technology", 7th Ed., Prentice Hall of India, 2011

Mode of evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sl. No.	Experiments	Hrs.	SLO
1	Determination of pH, Turbidity and conductivity (IS 3025 Part 11, 10 and 14)	30	14
2	Determination of Hardness (IS 3025 Part 21); Determination of Alkalinity (IS 3025 Part 23)		
3	Determination of Chlorides (IS 3025 Part 32)		
4	Determination of Sulfates (IS 3025 Part 24)		
5	Determination of fluoride (Standard Methods for examination of Water & Wastewater, APHA)		
6	Determination of Optimum Coagulant dosage		
7	Determination of residual chlorine and available chlorine in bleaching powder (IS 3025 Part 25 and 26)		
8	Determination of Oil, and Grease (IS 3025 Part 39)		
9	Determination of suspended, settleable, volatile and fixed solids (IS 3025 Part 15, 17, 18, and 19)		
10	Determination Dissolved Oxygen and BOD for the given sample (IS 3025 Part 38 and 44)		
11	Determination of COD for given sample (IS 3025 Part 58)		
12	Determination of SVI of Biological sludge and microscopic examination		
13	Determination of MPN index of given water sample (IS 5401 Part 1)		
14	Estimation of Nitrate a in water using UV-Visible Spectrometer		
15	Combined estimation of anions (Flouride, Chloride, Bromide, Nitrate, Phosphate, Sulphate) in water using Ion Chromatography		

Sample projects for J component (60 hrs)

SL. No.	Project areas
1.	Design of advanced water and wastewater treatment units
2.	Application of software in design of treatment units
3.	Design and execution of experiments to generate data needed for design of various treatment reactors
4.	Process development/modification
5.	Application of nanomaterials in water and wastewater treatments
6.	Understanding the problem of excessive use of nanomaterials – how this effect conventional treatment units
7.	Water and wastewater quality analysis – identification of source of pollution with the help of mathematical models/software
8.	Water quality modeling
9.	Selection of treatment units – developing management models
10.	Groundwater quality monitoring
11.	Fabrication and evaluation of treatment units for diverse liquid waste
12.	Integrated treatment units
13.	Cost –benefit analysis of various treatment units – this will be done using existing data
14.	Health monitoring of local Rivers
15.	River water quality management

Course Code	CONSTRUCTION MATERIALS AND TECHNIQUES	L	T	P	J	C
CLE1007		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the physical and mechanical properties of construction materials and their respective testing procedure.
2. To know the building materials available in market for construction purpose.
3. To learn the principles and methods to be followed in construction of various civil engineering structures.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the relevant physical and mechanical properties of construction materials.
2. Choose the modern construction material appropriate to the climate and functional aspects of the buildings.
3. Select the construction technique to be followed in brick, stone and hollow block masonry, concreting, flooring, roofing, plastering and painting etc.

Student Learning Outcomes (SLO):	2,11,17		
Module: 1	**Introduction to Civil Engineering**	**5 hours**	**SLO:** 2
Role of Civil Engineers in Society; Outstanding accomplishments of the profession; Future trends. Techno-economic considerations			
Module: 2	**Materials & its Properties**	**8 hours**	**SLO:** 2,17
Physical and Mechanical properties of construction materials - commonly used types of stones - Tests for stones, road aggregates and concrete aggregates, properties of sand, BIS specification for testing of aggregates –Bricks – Properties and testing methods for Bricks, Recycled Aggregates-Cement-Cement – Manufacturing -wet and dry processes, constituents and constitution, properties - Types of cement – Testing of Cement			
Module: 3	**Modern Construction Materials**	**6 hours**	**SLO:** 2,11
Modern materials – Neoprene, thermocole, decorative panels and laminates, architectural glass and ceramics, ferrocement, PVC, polymer base materials, fibre reinforced plastics.			
Module: 4	**Roofing Material**	**6 hours**	**SLO:** 2, 17
Structural Steel and Aluminium – Roofing Material – Physical descriptions of asbestos sheets, GI sheets, tubes and light weight roofing materials - Timber - Types, Seasoning and various products			
Module: 5	**Prefabricated Construction**	**8 hours**	**SLO:** 2, 17
Prefabricated panels and structures – production, transportation and erection of structures- Types of projects; Stages of projects; Participants in projects and their role; Techno-economic considerations; Project failures and their causes - Case studies			
Module: 6	**Construction Components**	**7 hours**	**SLO:** 2,11
Principles of construction – Selection of suitable type of masonry – Reinforced brick work – Stone masonry – Hollow block masonry - Pointing and Plastering- its purpose – Damp proof Course (DPC)- Anti-termite measures and treatments-Construction Joints- need and materials used			
Module: 7	**Scaffolding**		**SLO:** 2
Types of scaffolding and centering-its suitability as per situations and the type of structures.			
Module: 8	**Contemporary issues**	**2 hours**	**SLO:** 2, 17
Total Lecture hours		**45 hours**	

Text Book(s)			
1.	Rangwala, (2016), Building construction, Charotar Publishers		
Reference Books			
1.	Ken Ward-Harvey (2009) (fourth edition), Fundamental building materials, Universal Publisher.		
2.	Edward Allen, Joseph Iano (2013) Fundamentals of Building Construction; Materials and Methods, Willey Publications		
3.	Rangwala, (2015), Engineering materials, Charotar Publishers		
4.	Edward Allen, Joseph Iano (2014) (Sixth Edition), Fundamental building materials, John Wiley & sons inc (Publisher).		
Mode of evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	16.08.2017		
Approved by Academic Council	46^{th} ACM	Date	24.08.2017

Course Code	BUILDING DRAWING	L	T	P	J	C
CLE2001		1	0	2	4	3
Pre-requisite	**CLE1007 – Construction Materials and Techniques**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the regulations as per National Building Code
2. To identify the functional requirements and building rules
3. To understand the sketches and working drawings

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Implement the regulations for layout planning and preparation of drawings.
2. Prepare building drawings for residential building and hospital buildings.

Student Learning Outcomes (SLO):	1, 4, 5

Module: 1	**Introduction to Building Drawing**	**2 hours**	**SLO:** 4, 5
Types of Buildings - Building Regulations as per Indian Standards - Drawing Tools - Standard Paper Size - BIS, ISO, Architecture and ANSI Specifications and Notations.			
Module: 2	**GUI of AutoCAD**	**2 hours**	**SLO:** 4, 5
Basic Commands - 2D Drafting and Annotation - Sheets and Layouts - Blocks and Customizing AutoCAD. Introduction to Building Information Modeling			
Module: 3	**Building Planning**	**2 hours**	**SLO:** 4, 5
Provisions of National Building Code - Building bye-laws - open area - setbacks - FAR terminology - Principles of planning - orientation - ventilation and lighting. Provisions for differently abled persons.			
Module: 4	**Building Elements**	**2 hours**	**SLO:** 4, 5
Foundations - Plinth beam - Column- Beam - Slab- Lintel - Staircase - doors and windows - Types - Specifications - Standard sizes - Notations.			
Module: 5	**Roof Types**	**1 hour**	**SLO:** 4,5
Flat and Pitched roofs.			
Module: 6	**Planning of Residential and Hospital buildings**	**2 hours**	**SLO:** 1**,** 4,5
Single bed room - double bed-room - multi-storey buildings - Hospitals buildings with Pharmacy and Dispensaries.			
Module: 7	**Institutional, Commercial and Industrial buildings**	**2 hours**	**SLO:** 1, 4, 5
School Building with Hostel - Workshop and Factory buildings with steel truss			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**15 hours**	

Text Book(s)

1.	Kumara Swamy N and Kameswara Rao A, "Building Planning And Drawing", Charotar Publishing House Pvt. Ltd., 2013.

Reference Books

1.	Gurcharan Singh, “Civil Engineering Drawing”, Standard Publishers, New Delhi, 2009.
2.	Randy Shih, “Autocad 2016 Tutorial First Level - 2D Fundamentals”, Schroff Development Corp, 2015.
3.	Mark W. Huth Delmar, "Understanding Construction Drawings", Cengage Publishers, 2013.
4.	National Building Code of India 2005, Reprint edition, Bureau of Indian Standards, Govt. of India, 2013.

	Laboratory	L Hrs	SLO
Preparation of line sketches in accordance with functional requirements and building rules for the following types of building as per National Building Code:			
1.	Flat roof residential building	**8**	**4, 5**
2.	Pitched roof residential building		
3.	Multi-storeyed building		
4.	Industrial Building		
Detailed Drawings (Plan, Elevation and section for the following) by manual and by using AutoCAD:			
5	Detailed drawing for doors, windows.	**22**	**4,5**
6	Planning, design and detail drawings of staircase		
7	Flat roof building with load bearing wall		
8	Pitched roof with load bearing wall		
9	Framed structures		
10	Industrial Building with North light roof truss		
	Total Lecture Hours	**30**	

Sample project titles for J component (60 hours)

Sample Project Titles

1. Prepare the detailed plan for Primary health center
2. Prepare the detailed plan for a hostel building
3. Prepare the detailed plan for a secondary school building
4. Prepare the detailed plan for a manufacturing industry
5. Prepare the detailed plan for a shopping mall
6. Prepare the detailed plan for a library building
7. Prepare the detailed plan for apartments

Mode of evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	STRENGTH OF MATERIALS	L	T	P	J	C
CLE2002		2	2	2	0	4
Pre-requisite	**MEE1002 Engineering Mechanics**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the concept of stresses and strains
2. To draw the SFD & BMD
3. To calculate deflection in beams and trusses

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Determine the internal forces in the beams
2. Formulate the expressions for deflection
3. Identify the behavior of beams and columns

Student Learning Outcomes (SLO):	1, 2, 14		
Module: 1	**Simple Stresses and Strains**	**5 hours**	**SLO:** 1, 2, 14

Stress - Strain-types of stresses and strain - Hooke's law - tension -compression and shear - stress-strain diagrams - relation between elastic constants - Hoop stress - composite bars in tension and compression - Principle of superposition - bars of varying sections and of different materials - Thermal stresses and strains - principal stresses and strains - Mohr's circle. Theory of failures.

Module: 2	**Shear Force and Bending Moment**	**5 hours**	**SLO:** 1, 2

Beams and Bending - Types of loads, supports - Shear Force and Bending Moment Diagrams for statically determinate beam with concentrated load, uniformly distributed load, uniformly varying load - Point of Contra flexure - Theory of Simple bending - Distribution of bending stresses and shear stress.

Module: 3	**Deflection of Beams**	**5 hours**	**SLO:** 1, 2,14

Slope and deflection of beams - Macaulay's method - Moment area method - Conjugate beam method.

Module: 4	**Thin and Thick Shells**	**3 hours**	**SLO:** 1, 2

Introduction - Thin Cylindrical shells - hoop stress - longitudinal stresses - Lame's theory - Design of thin & thick cylindrical shells.

Module: 5	**Torsion in circular shaft**	**3 hours**	**SLO:** 1,2

Torsion - Torsion equation - solid and hollow circular shaft - Torsional rigidity - power transmitted by the shafts

Module: 6	**Theory of Columns**	**3 hours**	**SLO:**1,2,14

Theory of columns - Long column and short column - Euler's formula - Rankine's formula - Secant formula - Beam column

Module: 7	**Introduction to determinate and indeterminate structures**	**4 hours**	**SLO:** 1,2,14

Castigliano's I theorem - unit load method - Maxwell-Betti theorem

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	R Subramanian, Strength of Materials, Oxford University Press, 2010

Reference Books

1.	Gere, J.M. and Goodno, B.J., "Strength of Materials", Indian Edition (4th reprint), Cengage Learning India Private Ltd., 2009.
2.	Beer, F.P., Johuston, Jr., E.R., Dewolf, J.T. and Mazureu, D.E., "Mechanics of Materials", Fifth Edition, McGraw Hill, 2009.

3.	Timoshenko, S.P. and Young, D.H., “Elements of Strength of Materials”, Fifth Edition, (In MKS Units), East-West Press Pvt. Ltd., 2009.		
4.	Bansal R. K, "Strength of Materials", Laxmi Publications, 2010.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

S. No.	Laboratory Exercises	Hrs	SLO
1.	Tension test on steel for finding stress and strain and E.	30	14
2.	Construction of Mohr’s circle using principle stress.		
3.	Sketching a shear force and bending moment diagrams for different types of beams with different loading conditions.		
4.	Torsion test.		
5.	Shear stress.		
6.	Bending stress.		
7.	Finding the deflection of beams.		
8.	Load carrying capacity of long and short columns.		

Course Code	STRUCTURAL ANALYSIS	L	T	P	J	C
CLE2003		2	2	0	0	3
Pre-requisite	**CLE2002 Strength of Materials**	**Syllabus version**				
		1.1				

Course Objectives:

1. To know the different methods available for the analysis of structures and understand the concept
2. To identify the best suitable method of analysis

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Apply the different methods for analysis of structures
2. Use energy concepts in the analysis
3. Understand the importance of the force and displacement method
4. Apply the influence line diagram for moving loads

Student Learning Outcomes (SLO):	1, 2, 14		
Module: 1	**Introduction to Civil Engineering**	**2 hours**	**SLO:** 1, 2, 14
Static and kinematic indeterminacy - Beam - Truss - Frame.			
Module: 2	**Theorem of Three Moments**	**2 hours**	**SLO:** 1, 2, 14
Analysis of propped cantilevers - fixed and continuous beams - bending moment and shear force diagram.			
Module: 3	**Strain Energy Method**	**4 hours**	**SLO:** 1,2,14
Static indeterminacy - analysis of indeterminate structures, beams, pin jointed and rigid jointed structures - temperature effect - bending moment and shear force diagram.			
Module: 4	**Slope Deflection Method**	**5 hours**	**SLO:** 1,2, 14
Kinematic indeterminacy - analysis of continuous beams and portals - bending moment and shear force diagram.			
Module: 5	**Moment Distribution Method**	**4 hours**	**SLO:** 1,2, 14
Analysis of continuous beams and portals - bending moment and shear force diagram.			
Module: 6	**Influence Lines**	**4 hours**	**SLO:** 1, 2,14
Influence lines for bending moment and shear force - Muller Breaslau's - principle - determinate and indeterminate beams - Maxwell's reciprocal theorem.			
Module: 7	**Analysis of Arches & Cables**	**5 hours**	**SLO:** 1, 2, 14
Twohinged and three hinged arches - Cables tension forces in towers.			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Reddy, C.S, "Structural Analysis", Tata McGraw Hill, 2010.

Reference Books

1.	Bhavikatti S. S. "Structural Analysis 1", Vikas Publishing House, Noida, 2011.
2.	Punmia, B.C, Ashok kumar Jain & Arun Kumar Jain, "Theory of Structures", Laxmi Publications, India, 2014.
3.	Ramamrutham, S. "Theory of structures", DhanpatRai publications. 2011.
4.	Hibbeler, R.C, "Structural Analysis", Pearson India, 2014.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	WATER RESOURCE ENGINEERING	L	T	P	J	C
CLE2004		2	0	2	4	4
Pre-requisite	**MEE1004 Fluid Mechanics**	**Syllabus version**				
		1.0				

Course Objectives:

1. To get the exposure about the developments of water resources for the purpose of controlling & utilising water for various purposes
2. To understand the concepts of irrigation, water supply, flood control and navigational improvement
3. To learn about land drainage & pollution control.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the different types & methods of irrigation for better water management
2. Know the occurrence & distribution of water resources
3. Implement the practices of structural design for water resources project

Student Learning Outcomes (SLO): 2, 7, 9, 17

Module: 1	**Precipitation Measurement and Analysis**	**4 hours**	**SLO:** 2,7

Hydrologic cycle and budget, Precipitation variability, rainfall and snow measurement techniques, design of precipitation gauging network, Hydrologic Abstractions-Infiltration-evaporation-evapotranspiration-interception and depression storage, rain harvesting-design procedure.

Module: 2	**Stream Flow**	**5 hours**	**SLO:**2, 7

Measurement of stream flow; factors affecting stream flow; hydrograph analysis, base flow separation, unit hydrograph and curve number methods of stream flow determination, synthetic unit hydrograph, hydrological modeling for stream flow estimation, methods for peak discharge estimation.

Module: 3	**Flood Analysis**	**3 hours**	**SLO:**7, 9

Design flood estimation, frequency analysis, flood routing, storm drainage design, flood migration, flood damage analysis.

Module: 4	**Ground Water**	**4 hours**	**SLO:**7, 9

Ground water hydrology, Application of Darcy's law and Aquifer characteristics, Models for Groundwater flow analysis, steady state well hydraulics – Fundamentals of unsteady state.

Module: 5	**Irrigation Practices**	**5 hours**	**SLO: 2, 7**

Need for Irrigation in India, Scope, National Water Policy, Physical properties of soil that influence soil moisture characteristics – Concept of soil water potential and its components, Crop water requirements-Irrigation Scheduling- Irrigation efficiencies – Duty-Delta-base period, Surface and Subsurface methods of Irrigation, Standards for irrigation water, Water logging and consequences – Salinity and alkalinity-Reclamation

Module: 6	**Canal Irrigation**	**4 hours**	**SLO: 2, 9**

Classification of canals, Alignment of canals, Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals; Sediment transport in canals, River training

Module: 7	**Irrigation structure**	**3 hours**	**SLO: 2, 7**

Design procedure for – Canal Head works-Canal regulators-Canal drop – Cross drainage works-Canal Outlet-Escapes, Lining and maintenance of canals

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1. Subramanya. K., " Engineering Hydrology" McGraw Hill Education (India) Pvt. Ltd. (2013)
2. Santosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, New Delhi, (2013)

Reference Books	
1.	Chow, V.T., Maidment, D.R. and Mays, W.L., (2010) “Applied Hydrology”, Tata McGraw Hill Education Pvt. Ltd.
2.	Punmia. B. C., Ashok Kumar Jain, Arun Kumar Jain and Pande Brij BasiLal, (2012) “Irrigation and Water Power Engineering”, Laxmi Publications (P) Ltd.
3.	Mays, L.W.(2010). Water Resources Engineering, John wiley and sons.
4.	Todd D.K. and Larry W. Mays (2005)” Groundwater Hydrology", John Wiley & Sons, Inc, New York.
5.	A.K. Rastogi, (2011) "Numerical Groundwater Hydrology", Penram International Publishing (India) Pvt. Ltd.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

WATER RESOURCES ENGINEERING LABORATORY

Laboratory exercises related to	L Hr	SLO
[1] Models for Groundwater flow analysis [2] Estimate seepage losses and reservoir losses. [3] Seepage analysis using software [4] Reservoir operation losses [5] Flood analysis [6] Rainfall runoff modeling	**30**	**17**

Project Titles (J component) **60hrs**

Sample projects

1. Advanced rain water harvesting structures
2. New methods of irrigation
3. Groundwater modeling using MODFLOW
4. Flood frequency analysis
5. Rainfall-runoff model

Course Code	TRANSPORTATION ENGINEERING	L	T	P	J	C
CLE2005		2	0	0	4	3
Pre-requisite	**CLE1007 Construction Materials and Techniques**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand various transportation modes
2. To know the various components involved in their respective modes and their basic design concepts.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know various highway constructions techniques and its maintenance
2. Understand the components of railway engineering and their functions
3. Identify the requirements of an Airport and Harbour

Student Learning Outcomes (SLO):	2, 6, 9		
Module: 1	**Highway Engineering**	**8 hours**	**SLO: 2, 6, 9**
Introduction to Transportation Systems, Classification of Roads, Highway Planning - Road cross section - camber, gradient, Super elevation - Sight distance - Horizontal and Vertical curve.			
Module: 2	**Highway Materials and Pavement Design**	**4 hours**	**SLO: 6, 9**
Highway materials – soil, aggregate, bitumen – testing and specifications - types of pavements – pavement design - pavement construction and maintenance.			
Module: 3	**Railway Engineering**	**3 hours**	**SLO:2, 9**
History and general features of Indian railways – Permanent way - Rails, sleepers, ballast and subgrade – types and functions			
Module: 4	**Geometric Design**	**4 hours**	**SLO: 6, 9**
Geometric design of railway track - Curves and superelevation - Points and crossings -Railway stations and yards - Signaling and interlocking.			
Module: 5	**Airport Engineering**	**2 hours**	**SLO: 2**
Air transportation in India - Airport classifications - Airport site selection.			
Module: 6	**Geometric design of Runway**	**5 hours**	**SLO: 6, 9**
Runway configurations – wind rose and orientation of runway - runway length- Corrections to runway length - runway geometric design – taxiway, exit taxiway, aprons, hangars – aircraft parking configuration and parking system - Landing and Visual aids			
Module: 7	**Harbour Engineering**	**2 hours**	**SLO: 2**
Water transportation – Harbours and ports - Classification – Features of harbour – Breakwaters – Docks – Wet and dry docks – Jetties.			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Highway Engineering by S.K. Khanna, C.E.G. Justo , A. Veeraragavan, 10th edition, published by Nemchand and Bro., Roorkee, (2014)
2.	Railway Engineering by Rangwala, 25th edition, Charotar publishing house private limited, Anand, India, (2015)
3.	Harbour, Dock & Tunnel Engineering- R.Srinivasan; Charotar Publishers, Ahmedabad, 2011
4.	Airport Planning and Design- S. K. Khanna, M.G.Arora & S.S.Jain; Nem Chand & Bros, 2012

Reference Books

1.	Planning & Design of Airports – Robert Horonjeff, Francis McKelvey; Tata Mc Grawhill, 2010
2.	Dock & Harbour Engineering- H.P. Oza & G.H.Oza; Charotar Publishers, Ahmedabad, 2013

3.	Railway Engineering 2nd Edition - Satish Chandra & M. M. Agarwal; Oxford University Press-New Delhi, 2013.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Project Titles (J component) **60hrs**

Challenging projects for Individual or a group will be given based on the basic and advancements in the course content.

Course Code	QUANTITY SURVEYING AND ESTIMATING	L	T	P	J	C
CLE3001		2	0	0	0	2
Pre-requisite	**CLE2001 Building Drawing**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the types of estimates
2. To identify the methods used for different structural components
3. To understand rate analysis and process of preparation of bills

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Prepare a detailed estimate for different types of structures
2. Prepare valuation reports and cost quality control

Student Learning Outcomes (SLO): 1, 2, 9

Module: 1	**Introduction- Methods of estimates**	**3 hours**	**SLO:** 2
General items of work in building – standard units –principles of working out quantities for detailed and abstract estimates –methods of estimates of buildings.			
Module: 2	**Quantity Estimation for Building**	**6 hours**	**SLO:** 1, 2, 9
Estimation of building - Short wall and long wall method - Centre line method - Report writing.			
Module: 3	**Quantity Estimation for Structural steel**	**5 hours**	**SLO:** 1, 2, 9
Estimate of R.C.C and structural Steel - Scheduling - Slab - beam-column.			
Module: 4	**Quantity Estimation for Roads**	**4 hours**	**SLO:** 1, 2, 9
Road estimation - earthwork fully in banking - cutting - partly cutting & partly filling - Detailed estimate and cost analysis for roads.			
Module: 5	**Analysis of Rates**	**3 hours**	**SLO:** 1, 2, 9
Rate analysis & preparation of bills - Data analysis of rates for various items of works - Sub-structure components - Rate analysis for R.C.C. slabs, columns and beams.			
Module: 6	**Tenders and contracts**	**3 hours**	**SLO: 2**
Tenders-Tender document - Cost & quality control - Contracts - Contracts - Types of contracts- Arbitration and legal requirements			
Module: 7	**Valuation**	**3 hours**	**SLO:**2
Valuation- Capitilized value - Depreciation - Value of building - Mortgage – Lease- Measurement book, Stores. BOT & EPC - Case studies.			
Module: 8	**Contemporary Issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Datta B.N. Estimating and costing, Charator Publishing House, 2012.

Reference Books

1.	Kohli D.D and Kohli R.C, "Estimating and Costing", 12th Edition, S.Chand Publishers, 2014.
2.	Vazirani V.N and Chandola S.P, “Estimating and costing", Khanna Publishers, 2015.
3.	Rangwala, C. "Estimating, Costing and Valuation", Charotar Publishing House Pvt. Ltd., 2015.
4.	Duncan Cartlidge, "Quantity Surveyor’s Pocket Book", Routledge Publishers, 2012.
6.	PWD Data Book
7.	CPWD Schedule of Rates (SoR)

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	BASICS OF STRUCTURAL DESIGN	L	T	P	J	C
CLE3002		2	2	2	0	4
Pre-requisite	**CLE2003 Structural Analysis**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the design concepts as per the standards
2. To learn the design methodologies for different structural members

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To design RCC beams, columns and foundation
2. To design the compression, tension and flexural members

Student Learning Outcomes (SLO):	1, 6, 17

Module: 1	**Introduction to Limit State method**	**4 hours**	**SLO:** 1, 6, 17
Introduction - Concept of limit state method - Analysis and design of singly and doubly reinforced rectangular and flanged beams.			
Module: 2	**Design of RC Slabs and Beams**	**4 hours**	**SLO:** 1, 6, 17
Design of different types of slabs - One way slab - two way slab – staircase			
Module: 3	**Design of RC Compression members**	**4 hours**	**SLO:**1, 6, 17
Design of short column for axial load - uniaxial – Introduction to biaxial bending.			
Module: 4	**Design of RC Foundation**	**4 hours**	**SLO:**1, 6, 17
Design of isolated and combined footing			
Module: 5	**Steel Sections and Types of Connections**	**5 hours**	**SLO:** 1, 6, 17
Introduction - properties of Rolled Steel Sections - permissible stress - Riveted and bolted connections – permissible stresses, efficiency - design for axial and eccentrically loaded members. Design of connections in tension members			
Module: 6	**Design of Tension and Compression members**	**3 hours**	**SLO:** 1, 6, 17
Types of sections – Net area – Net effective area of sections in tension –Slenderness ratio – Design of single section and compound section of compression members.			
Module: 7	**Simple and Built-up steel Beams**	**4 hours**	**SLO:** 1, 6, 17
Design of beams - simple and built-up beams - laterally supported and unsupported beams, concept of shear. Plate and gantry girders – Flexural members.			
Module: 8	**Contemporary issues**	**2 hours**	**SLO:** 1, 6, 17
Total Lecture hours		**30 hours**	

Text Book(s)

1.	Subramanian, N. "Design of Reinforced Concrete Structures", Oxford University Press, New Delhi, 2013.
2.	Subramanian, N. "Steel Structures - Design and Practice", Oxford University Press, 2011.

Reference Books

1.	Devadoss Menon and Pillai S., "Reinforced Concrete Design", McGraw Hill Education India Private Limited; 3rd edition 2009.
2.	Raju N. Krishna, "Reinforced Concrete Design: Principles and Practice", CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2012.
3.	Duggal,S.K, Limit State Design of Steel Structures, Tata Mc Graw-Hill Education, 2014.
4.	IS 456: 2000 Plain and Reinforced Concrete - Code of Practice.

5.	IS 800: 2007 General Constructions in Steel - Code of Practice.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sl. No	Laboratory Exercises	L Hr	SLO
1. 2.	RCC: Design of doubly reinforced beams Design of two way slabs Design of short columns. Design of combined footing Design of staircases STEEL: Design of Built up beams Design of laterally supported and unsupported Beams Design of gantry girders Design of welded connections in framed structures	30	1, 6, 17

Course Code	APPLICATIONS OF DIFFERENTIAL AND DIFFERENCE EQUATIONS	L	T	P	J	C
MAT2002		3	0	2	0	4
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus Version				
		1.0				

Course Objectives:

- To provide a comprehensive coverage at an introductory level to the subject of ordinary differential equations and difference equations to solve engineering application oriented problems.
- To understand the nuances of Matrix methods, Laplace transform techniques and eigenvalue problems.
- To introduce Z transform technique to solve Difference equations.

Expected Course Outcome:

At the end of this course the students are expected to

- learn and understanding of the Fourier series in Engineering .
- Analyze the problems connected with Matrices, Eigen Values and Vectors, Canonical Forms.
- Identify solutions of differential equations by Laplace transforms in Engineering.
- Identify Z-transforms and its applications in difference equations

Student Learning Outcomes (SLO):	1,2,9

Module:1	Fourier series	6 hours	SLO: 1,2

Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval- half range series – RMS value – Parseval's identity – Computation of harmonics.

Module:2	Matrices	6 hours	SLO: 1,9

Eigen values and Eigen vectors - properties of Eigen values and Eigen vectors-Cayley Hamilton theorem -similarity of transformation-orthogonal transformation and nature of quadratic form.

Module:3	Solution of Ordinary differential equations	6 hours	SLO: 2,9

Linear second order ordinary differential equation with constant coefficients– solutions of homogenous and non-homogenous equations- method of undetermined coefficients –method of variation of parameters- Solutions of Cauchy-Euler and Cauchy Legendre differential equations.

Module:4	Solution of differential equations through Laplace transform and matrix method:	8 hours	SLO: 1,9

Solution of ODEs - Non homogeneous terms involving Heaviside function - Impulse function - Solving non homogeneous system using Laplace transform. Solving non homogeneous first order system of differential equations $(X' = AX + G, X'' = AX)$ - Reduction of nth order differential equation to first order system**.**

Module:5	Strum Liouville Problems and Power Series Solutions	6 hours	SLO: 1,9

The Strum-Liouville Problem-orthogonality of Eigen functions - Series solutions of differential equation about ordinary and regular singular points-Legendre differential equations - Bessel's differential equations

Module:6	Z-Transform	6 hours	SLO: 2,9

Z-transform-relation between Z-transform and Laplace Transforms – Z-transforms of standard functions - Inverse Z-transforms: by partial fraction method, by convolution method

Module:7	Difference Equation	5 hours	SLO: 1,9

Difference equation-first and second order difference equations with constant coefficients-Fibonacci sequence-solution of difference equations-complementary functions - particular integrals by the method of undetermined coefficients - solution of simple difference equations using Z-transforms.

Module:8	Contemporary Issues	2 hours	

Industry Expert Lecture			
	Total Lecture hours	**45 hours**	

Text Book(s)

1.	Advanced Engineering Mathematics by Erwin Kreyszig, 10th Edition, John Wiley India, 2015.

Reference Books

1.	Higher Engineering Mathematics by B.S.Grewal, 43rd Edition, Khanna Publishers, India, (2015).
2.	Advanced Engineering Mathematics by Michael D. Greenberg, 2nd Edition, Pearson Education, Indian edition (2006).

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Challenging Experiments (Indicative)		**SLO: 1,2,9**
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy, Legendre equations	2 hours
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors.	2 hours
6.	Solving system of differential equations arising in engineering applications	2 hours
7.	Applying the Power series method to solve differential equations arising in engineering applications	2 hours
8.	Applying the Frobenius method to solve differential equations arising in engineering applications	2 hours
9.	Visulizing Bessel and Legendre polynomials	2 hours
10.	Evaluating Fourier series-Harmonic series	2 hours
11.	Applying Z-Transforms to functions encountered in engineering	2 hours
12.	Solving Difference equations arising in engineering applications	2 hours
Total Laboratory Hours		**24 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test

Recommended by Board of Studies	16-08-2017		
Approved by Academic Council	47th ACM	Date	05-10-2017

Course Code	COMPLEX VARIABLES AND PARTIAL DIFFERENTIAL EQUATION	L	T	P	J	C
MAT3003		3	2	0	0	4
Pre-requisite	MAT2002 Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives:

The aim of this course is to present a comprehensive, compact and integrated treatment of two most important branches of applied mathematics for engineers and scientists namely

- the functions of complex variable and
- Partial differential equations in finite and infinite domains.

Expected Course Outcome:

By the end of the course, the students are expected to

- Develop the necessary mathematical skills, physical understanding of problems and intuition to independently analyze the mathematical equations which model the problems in their respective fields of study
- Develop design and innovative skills to apply complex variables and partial differential equations in Engineering

Student Learning Outcomes (SLO):	SLO: 1,2,9

Module: 1	Analytic Functions	6 hours	SLO: 1,2

Complex variable-Analytic functions and Cauchy – Riemann equations - Laplace equation and Harmonic functions - Construction of Harmonic conjugate and analytic functions - Applications of analytic functions to fluid-flow and Field problems.

Module: 2	Conformal and Bilinear transformations	5 hours	SLO: 2,9

Conformal mapping - Elementary transformations-translation, magnification, rotation, inversion. Exponential and Square transformations ($w = e^z$, z^2) - Bilinear transformation - Cross-ratio-Images of the regions bounded by straight lines under the above transformations.

Module: 3	Power series	4 hours	SLO: 1,2

Functions given by Power Series - Taylor and Laurent series -singularities - poles – Residues.

Module: 4	Complex Integration	5 hours	SLO: 2,9

Integration of a complex function along a contour - Cauchy-Goursat theorem- Cauchy's integral formula -Cauchy's residue theorem - Evaluation of real integrals - Indented contour integral.

Module: 5	Partial Differential equations of first order	6 hours	SLO: 1,9

Formation and solution of partial differential equation - General, Particular, Complete and Singular integrals - Partial Differential equations of first order of the forms: F(p,q)=0, F(z,p,q)=0, F(x,p)=G(y,q) and Clairaut's form - Lagrange's equation: Pp+Qq = R.

Module: 6	Applications of Partial Differential equations	10 hours	SLO: 2,9

Linear partial differential equations of higher order with constant coefficients. Solution of a partial differential equation by separation of variables - Boundary Value Problems-one dimensional wave and heat equations- Fourier series solution.

Module: 7	Fourier transforms	7 hours	SLO: 1,9

Complex Fourier transform and properties - Relation between Fourier and Laplace transforms - Fourier sine and cosine transforms – Convolution Theorem and Parseval's identity.

Module: 8	Contemporary Issues	2 hours	

Industry Expert Lecture

	Total Lecture hours	45 hours	
Tutorial	• A minimum of 10 problems to be worked out by students inventory Tutorial Class • Another 5 problems per Tutorial Class to be given as	30 hours	SLO: 1,2,9

	home work.		

Text Book(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons (Wiley student Edison) (2015)

Reference Books

1. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition (2013), Khanna Publishers, New Delhi
2. G.DennisZill, Patrick D. Shanahan, A first course in complex analysis with applications, 3rd Edition, 2013, Jones and Bartlett Publishers Series in Mathematics:
3. Michael, D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson Education (2002)
4. Peter V. O' Neil, Advanced Engineering Mathematics, 7th Edition, Cengage Learning (2011)
5. JH Mathews, R. W. Howell, Complex Analysis for Mathematics and Engineers, Fifth Edition (2013), Narosa Publishers

Mode of Evaluation

Digital Assignments(Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test

Recommended by Board of Studies	16.08.2017		
Approved by Academic Council	47th ACM	Date	05.10.2017

Course Code	APPLIED NUMERICAL METHODS	L	T	P	J	C
MAT3005		3	2	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives:

- The aim of this course is to cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences. The students are expected to use MATLAB as the primary computer language to obtain solutions to a few assigned problems.
- On completion of this course, the students are expected to appreciate the power of numerical methods and use them to analyze the problems connected with data analysis, and solution of ordinary and partial differential equations that arise in their respective engineering courses.

Expected Course Outcome

At the end of this course the students are expected to learn

- the difference between exact solution and approximate solution.
- the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations.
- how to fit the data using interpolation technique and spline methods.
- how to find the numerical solution of ordinary differential equations.
- the solution of Heat and Wave equation numerically.

Student Learning Outcomes (SLO):	**1,2,7**		
Module: 1	**Algebraic and Transcendental Equations**	**5 hours**	**SLO:** 1,2

General iterative method- rates of convergence- Secant method - Newton – Raphson method- System of non-linear equations by Newton's method.

Module: 2	**System of Linear Equations and Eigen Value Problems**	**6 hours**	**SLO:** 2,7

Gauss –Seidel iteration method. Convergence analysis of iterative methods-LU Decomposition - Tri diagonal system of equations-Thomas algorithm- Eigen values of a matrix by Power and Jacobi methods.

Module: 3	**Interpolation**	**6 hours**	**SLO:** 2,7

Finite difference operators- Newton's forward-Newton's Backward- Central differences-Stirling's interpolation - Lagrange's interpolation - Inverse Interpolation-Newton's divided difference-Interpolation with cubic splines.

Module: 4	**Numerical Differentiation and Integration**	**6 hours**	**SLO:** 1,2

Numerical differentiation with interpolation polynomials-maxima and minima for tabulated values-Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules. –Romberg's method. Two and Three point Gaussian quadrature formula.

Module: 5	**Numerical Solution of Ordinary Differential Equations**	**8 hours**	**SLO:** 1,7

First and second order differential equations - Fourth order Runge – Kutta method. Adams-Bashforth-Moulton predictor-corrector methods. Finite difference solution for the second order ordinary differential equations.

Module: 6	**Numerical Solution of Partial Differential Equations**	**6 hours**	**SLO:** 2, 7

Classification of second order linear partial differential equations-Laplace equation –Gauss-Seidal method-One dimensional heat equation- Schmidt explicit method-Crank-Nicolson implicit method.-One dimensional wave equation–Explicit method.

Module: 7	**Vibrational Methods**	**6 hours**	**SLO:** 1,7

Introduction to calculus of variations -Definition of functional - Extremals of functional of a single

dependent variable and its first derivative-Functional involving higher order derivatives-Functional involving several variables Isoperimetric problems-Galerkins method.			
Module: 8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
Total Lecture hours		**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class. • Another 5 problems per Tutorial Class to be given for practise.	**30 hours**	**SLO:** 1,2,7

Text Book(s)

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering, New Age International Ltd., 6th Edition, 2012.
2. C. F. Gerald and P.V. Wheatley Applied Numerical Analysis, Addition-Wesley, 7th Edition, 2004.

Reference Books

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.
2. W.Y. Yang, W. Cao, T.S. Chung and J. Morris, Applied Numerical Methods Using MATLAB, Wiley India Edn., 2007.
3. Steven C. Chapra and Ra P. Canale, Numerical Methods for Engineers with Programming and Software Applications, 7th Edition, Tata McGraw Hill, 2014.
4. R.L. Burden and J. D. Faires, Numerical Analysis, 4th Edition, Brooks Cole, 2012.

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	16.08.2017		
Approved by Academic Council	47th ACM	Date	05.10.2017

Course Code	ENGINEERING DRAWING	L	T	P	J	C
MEE1001		1	0	4	0	3
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. xx.xx				

Course Objectives:

- To follow basic drawing standards and conventions.
- To develop skills in three-dimensional visualization of engineering components.
- To prepare sectional views of solids.
- To draw the development of surfaces and estimate the sheet metal requirement.
- To develop an understanding of solid modelling using CAD software.

Expected Course Outcome:

- Prepare drawings as per standards.
- Solve specific geometrical problems in plane geometry involving lines, plane figures and special Curves.
- Prepare sectional views of solids.
- Draw isometric drawings of combined solids and simple components.
- Produce orthographic projection of engineering components working from pictorial drawings.
- Prepare solid modelling of machine components using CAD software.

Student Learning Outcomes (SLO):	5, 6, 17

Module: 1	Lettering and Dimensioning	1 hour	SLO: 5, 6, 17

Introduction, lettering practice, Elements of dimensioning - systems of dimensioning.

Module: 2	Geometric Constructions	2 hours	SLO: 5, 6, 17

Free hand sketching, Conic sections, Special curves.

Module: 3	Projection of Points and Projection of Lines	3 hours	SLO: 5, 6, 17

Projection of Points: First and Third Angle Projections; Projection of points.
Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.

Module: 4	Projection of Solids and Section of Solids	3 hours	SLO: 5, 6, 17

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.
Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.

Module: 5	Development of Surfaces	2 hours	SLO: 5, 6, 17

Development of surfaces for various regular solids.

Module: 6	Isometric Projection and Perspective Projection	2 hours	SLO: 5, 6, 17

Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids;
Perspective Projection: Orthographic representation of a perspective views – Plane figures and simple solids - Visual ray method.

Module: 7	Orthographic Projection	1 hour	SLO: 5, 6, 17

Conversion of pictorial view into orthographic Projection.

Module: 8	Contemporary issues	1 hour	
	Total Lecture hours	15 hours	

Text Book(s)

1. Venugopal K and Prabhu Raja V, “Engineering Graphics”, New AGE International Publishers, 2015.

Reference Books			
1.	N. D. Bhatt, Engineering Drawing, Charotar publishing House, 2012.		
2.	Natarajan, K. V., A Text book of Engineering Graphics, Dhanalakshmi Publishers, 2012.		
List of Challenging Experiments (Indicative) to be done using both Manual and CAD tools.		**SLO: 17**	
1.	Identifying the incorrect dimensioning and correct it as per BIS standards for Engineering Components.		4 hours
2.	Tutorials on free hand sketching of the plan view of stadium, garden, etc.,		4 hours
3.	Tutorials on geometric constructions like conics and special curves for projection of cricket ball, missile projection, etc.,		4 hours
4.	Representation of orthographic projection of points		4 hours
5.	Representation of orthographic projection of lines (First angle projection only) inclined to one plane and projection of lines inclined to both the planes- solving problems like electrical bulbs hanging from the roof, finding the shortest distance between fan to electrical switch board, etc.,		12 hours
6.	Sketching orthographic projection of solids in simple position and projection of solids inclined to one plane for household accessories and objects.		8 hours
7.	Drawing the auxiliary views, orthographic views and true shape of sectioned regular solids for household accessories and objects.		4 hours
8.	Development of lateral surfaces of the regular shapes and sectioned shapes for water cans, refrigerator, cylinder container, funnel, etc.,		4 hours
9.	Conversion of orthographic views to isometric views for engineering components.		8 hours
10.	Tutorial problems on perspective projection of plane figures and simple solids for train with track, landscape, etc.,		4 hours
11.	Conversion of pictorial drawing into orthographic projection for engineering components, architectural structures, etc.,		4 hours
Total Laboratory Hours			**60 hours**
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47^{th} ACM	Date	05-10-2017

Course Code	ENGINEERING MECHANICS	L	T	P	J	C
MEE1002		2	2	0	0	3
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. xx.xx				

Course Objectives:

- Find the reaction forces
- Use equilibrium equations to obtain unknown forces and moments
- Understand the properties of surfaces
- Use the equations of motion and various concepts to dynamics of particles and rigid bodies

Expected Course Outcome:

- Apply the basic concepts to various Engineering problems
- Realize the effect of external forces, reactions, moments on various structures with or without friction
- Determine the centroid, second moment of area and mass moment of inertia on different surfaces and solids
- Apply various concepts to find the acceleration and forces of particles and rigid bodies

Student Learning Outcomes (SLO): 1, 2, 9

Module: 1	**Basics of Statics**	**5 hours**	**SLO: 1, 2, 9**

Fundamental Principles - Coplanar forces - Resolution and Composition of forces and equilibrium of particles - Forces of a particle in space - Equivalent system of forces - Principle of transmissibility - Single equivalent force - Free body diagram - Equilibrium of rigid bodies in two dimensions and three dimensions

Module: 2	**Analysis of Structures**	**4 hours**	**SLO: 1, 2, 9**

Types of supports and their reactions - Plane trusses and frames - Analysis of forces by method of joints and method of sections

Module: 3	**Friction**	**3 hours**	**SLO: 1, 2, 9**

Characteristics of dry friction – simple contact friction – Wedges and Ladder friction

Module: 4	**Properties of Surfaces and Solids**	**4 hours**	**SLO: 1, 2, 9**

Centroid - First moment of area – Second moment of area – Moment and product of inertia of plane areas – Transfer Theorems - Polar moment of inertia – Principal axes – Mass moment of inertia

Module: 5	**Virtual Work**	**4 hours**	**SLO: 1, 2, 9**

Virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom – Conservative forces – Potential energy – Potential energy criteria for equilibrium.

Module: 6	**Kinematics**	**4 hours**	**SLO: 1, 2, 9**

Displacements, Velocity and Acceleration – Rectilinear motion – Curvilinear motion – Tangential and Normal components – Radial and Transverse components.

Module: 7	**Energy and Momentum Methods**	**4 hours**	**SLO: 1, 2, 9**

Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum.

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. Beer, Johnston, Cornwell and Sanghi (2013) Vector Mechanics for Engineers: Statics and Dynamics, 10th Edition, McGraw-Companies, Inc., New York.

Reference Books

1. Russell C Hibbeler and Ashok Gupta (2010), Engineering Mechanics: Statics and Dynamics (11th

	Edition), Published by Pearson Education Inc., Prentice Hall.
2.	Meriam J.L and Kraige L.G. (2012) Engineering Mechanics, Volume I - Statics, Volume II - Dynamics, 7th Edition, John Wiley & Sons, New York.
3.	Rajasekaran S and Sankarasubramanian G (2013), Fundamentals of Engineering Mechanics, 3rd Edition, Vikas Publishing House Pvt Ltd., India.
4.	Nelson A, (2009), Engineering Mechanics Statics and Dynamics, Tata McGraw Hill Education Pvt. Ltd., New Delhi, India.

Tutorials	**SLO: 1, 2, 5**

A minimum of 3 problems to be worked out by students in every Tutorial Class. Another 5 problems per Tutorial Class to be given as home work. At least one open ended design problem to be given.

1.	Module-1	4 hours
2.	Module-2	4 hours
3.	Module-3	2 hours
4.	Module-4	6 hours
5.	Module-5	4 hours
6.	Module-6	4 hours
7.	Module-7	6 hours
Total Tutorial Hours		**30 hours**

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47th ACM	Date	05-10-2017

Course Code	FLUID MECHANICS	L	T	P	J	C
MEE1004		2	2	2	0	4
Pre-requisite	NIL	Syllabus version				
Anti-requisite	MEE1032	v. xx.xx				

Course Objectives:

- Provide a strong foundation in the fundamentals of fluid mechanics to the students of various engineering disciplines and
- To develop an appreciation for the properties of fluids and their behaviour under various conditions of internal and external flows.
- To develop an understanding of the hydrostatic law, the principle of buoyancy and stability of a floating body.
- To imbibe basic laws and equations used for analysis of static and dynamic fluids.
- Enable students to gain knowledge of the flow through pipes, losses in a flow system, fluid flow measurement and its applications in Industries.
- To inculcate the importance of the concept of dimensional analysis, boundary layer flow and flow past immersed bodies.

Expected Course Outcome:

- Apply the fundamental knowledge of fluid mechanics to develop analytical solutions to a variety of simplified fluid flow problems in mechanical and civil engineering.
- Determine flow rates, pressure changes, minor and major head losses for viscous flows through pipes, ducts, simple networks and open channel systems
- Apply principles of dimensional analysis and similitude to simple problems
- Conduct experiments in the pipe and open-channel fluid flows. Ability to interpret and document the experimental data.

Student Learning Outcomes (SLO): 1, 2, 14

Module: 1	Introduction to Fluid Statics	4 hours	SLO: 1, 2,14

Definition of fluid, Concept of continuum, Fluid properties, Classification of fluids, Pascal's and Hydrostatic Law, Pressure and its variation in a static Fluid, Measurement of static fluid pressure: Manometers

Module: 2	Hydrostatic Forces and Buoyancy	4 hours	SLO: 1, 2,14

Hydrostatic forces on Plane –Inclined and Curved surfaces, Buoyancy, Condition of Equilibrium for Submerged and Floating Bodies, Centre of Buoyancy, Metacentre–Determination of Metacentric Height.

Module: 3	Fluid Kinematics and Dynamics	6 hours	SLO: 1, 2,14

Fluid kinematics: Description of fluid motion – Lagrangian and Eulerian approach, Types of flows, Control volume, Material derivative and acceleration, Streamlines, pathlines and streaklines, Stream function and velocity potential function, Reynolds transport theorem

Fluid dynamics: Continuity equation, Euler and Bernoulli's equations – orifice meter, venturimeter, Momentum equation, Application of momentum equation – forces on curved pipes, Navier–Stokes Equations.

Module: 4	Flow through pipes	4 hours	SLO: 1, 2,14

Measurement in pipe flow-Major loss, Darcy–Weisbach equation, Moody's diagram, Minor losses, Multi reservoir problems, pipe network design, Hagen Poiseuille equation, Turbulent flow.

Module: 5	Open channel flow	3 hours	SLO: 1, 2,14

Types of open channel flows, Specific Energy, Specific force, Critical flow, Hydraulic jumps/Surges and gradually varying flow concepts, Measurement of discharge in open channels.

Module: 6	Dimensional Analysis	3 hours	SLO: 1, 2,14

Dimensional homogeneity, Raleigh's method, Buckingham π theorem, Non-dimensional numbers, Model laws and distorted models, Modelling and similitude

Module: 7	Boundary layer flow	4 hours	SLO: 1, 2,14
Boundary layers, Laminar flow and turbulent flow, Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of boundary layer, Methods of preventing the boundary layer separation			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Tutorials

- Minimum of 10 problems to be worked out by students in every 2 hours of tutorial Class per week
- Another 5 problems per tutorial class to be given as home work.
- The topics in each module will be given as follows
  Module 1: 4 hrs
  Module 2: 4 hrs
  Module 3: 6 hrs
  Module 4: 4 hrs
  Module 5: 4 hrs
  Module 6: 4 hrs
  Module 7: 4 hrs

30 hours

Text Book(s)

1.	Robert W. Fox, Alan T. McDonald, Philip J. Pirtchard John W. Mitchell (2015), Introduction to Fluid Mechanics, 9th Edition, Wiley Publications.

Reference Books

1.	P.N.Modi and S.M.Seth (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, 17th Edition.
2.	Yunus A. Çengel, John M. Cimbala (2013) Fluid Mechanics: Fundamentals And Applications, McGraw-Hill, 3rd Edition.
3.	Dr.R.K.Bansal, (2012), A Textbook of Fluid Mechanics and Hydraulic Machines, 5th Edition, Laxmi Publication.
4.	Donald F. Elger, Barbara C. Williams, Clayton T. Crowe, John A. Roberson (2013) Engineering Fluid Mechanics, John Wiley & Sons, 10th Edition.
5.	V.L. Streeter, (2010), Fluid Mechanics, McGraw Hill Book Co.

List of Challenging Experiments (Indicative)		SLO: 14
1.	Estimation of discharge from a given tank using orifice (constant head method)	3 hours
2.	Estimation of discharge from a given tank using mouthpiece (variable head method)	3 hours
3.	Determination of discharge in an open channel using rectangular Notch	3 hours
4.	Determination of discharge of a given pipe flow using venturimeter	3 hours
5.	Determination of discharge of a given pipe flow using orifice meter	3 hours
6.	Estimation of friction factor and major loss for a given flow system	3 hours
7.	Estimation of minor losses for a given pipe line	3 hours
8.	Determination of state of flow in a closed conduit using Reynold's experiment	3 hours
9.	Verification of conservation of energy principle for a given flow system using Bernoulli's Theorem	3 hours
10.	Estimating the flow rate in a pipe line using water meter	1.5 hours
11	Study and calibration of a pitot static tube	1.5 hours
Total laboratory hours		**30 hours**

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47th ACM	Date	05-10-2017

Course Code	NATURAL DISASTER MITIGATION AND MANAGEMENT	L	T	P	J	C
CLE1010		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.0				

Course Objectives:

1. To teach students about types of natural and environmental disasters.
2. To help students to develop skills in various stages of disaster preparedness, mitigation and management.
3. To teach the students the methodologies for disaster risk assessment.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Learn about the types of natural and environmental disasters and its causes.
2. Learn about organizational and Administrative strategies for managing disasters.
3. Learn about the early warning systems, monitoring of disasters effect and necessity of rehabilitation.
4. Learn about the engineering and non-engineering controls of mitigating various natural disasters.
5. Understand the key roles of capacity building to face disaster among government bodies, institutions, NGO's, etc.
6. Learn methodologies for disaster risk assessment with the help of latest tools like GPS, GIS, Remote sensing, information technologies, etc.

Student Learning Outcomes (SLO):	2, 9, 10

Module: 1	**Introduction**	**6 hours**	**SLO: 2**

Natural Disasters around the world- Natural Disaster Risk Assessment- Earth and its characteristics – Environmental Change and Degradation - Climate Change - Global warming – Human Dimensions of Global environment Change

Module: 2	**Disaster Preparedness**	**7 hours**	**SLO: 2, 9, 10**

Disaster mitigation, preparedness, response and recovery- comprehensive emergency management Early warning systems and Disaster Preparedness– Rehabilitation, Vulnerable Populations - Logistics and Services, Food, Nutrition and Shelter -Role of UN Red cross and NGOs.

Module: 3	**Principles**	**5 hours**	**SLO:2**

Natural Disasters -Principles, Elements, and Systems - Geological- Geomorphological, aspects, - Earthquake-Geology, Seismology, Characteristics and dimensions

Module: 4	**Landslides**	**3 hours**	**SLO:2, 9**

Human impact on the mountainous terrain and its relationship with Rainfall, liquefaction etc- Tsunami - Nature and characteristics - Monitoring landslides- Landslide Early warning System

Module: 5	**Oceanic, Atmospheric and Hydrologic cycles**	**6 hours**	**SLO:2, 9**

Severe Weather & Tornadoes , Cyclones, Floods and Droughts - Global Patterns - - Mitigation & Preparation – Drought – Famine- nature and dimensions – Drought Assessment and Monitoring.

Module: 6	**Mapping**	**8 hours**	**SLO:2, 9, 10**

Modelling, risk analysis and loss estimation – Natural disaster risk analysis - prevention and mitigation - Applications of Space Technology (Satellite Communications, GPS, GIS and Remote Sensing and Information / Communication Technologies (ICT) in Early warning Systems - Disaster Monitoring and Support Centre– Information Dissemination – Mobile Communications etc.

Module: 7	**Community and Social organizations**	**7 hours**	**SLO: 2, 9, 10**

Community based disaster management - Psychological effects after disasters - Socio Psycho care-managing Stress - Education and Training – Establishment of capacity building among various stake

holders – Government - Educational institutions – Use of Multi-media knowledge products for self education.			
Module: 8	**Contemporary issues**	**3 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1.	Ghanshyam Singh and Sandip Bhandari, Disaster Management, Gullybaba Publishing House (P) Ltd; 1 edition (2012), ISBN-13: 978-9381066492

Reference Books

1.	Bhandari, R.K, Disaster Education and Management, A Joyride for Students, Teachers and Disaster Managers, ISBN, 978-81-322-1565-3, XXVIII, 349, Springer India, 2014
2.	Brian Tomaszewski, Geographic Information Systems (GIS) for Disaster Management, December 19, 2014 by CRC Press, Textbook - 310 Pages - 148 B/W Illustrations, ISBN 9781482211689 - CAT# K21688
3.	Harsh K. Gupta, Disaster Management, Indian National Science Academy, ISBN 8173714568, 788173714566, 2006 second Edition, 152 Pages

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	ENGINEERING GEOLOGY	L	T	P	J	C
CLE1011		2	0	0	0	2
Pre-requisite	**NIL**	**Syllabus version**				
		2.0				

Course Objectives:

1. To demonstrate the importance of Geological knowledge in making engineering decisions
2. To introduce the fundamentals of the engineering properties of earth materials for the use of civil
   engineering constructions
3. To develop quantitative skills and a frame work for solving basic engineering geology problems

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Characterize of the engineering properties of rocks and soils
2. Assess the geological hazards
3. Use seismic and electrical methods for subsurface investigation

Student Learning Outcomes (SLO):	1, 2, 9		
Module: 1	**Earth Structure**	**4 hours**	**SLO: 1**
Relevance and importance of Engineering Geology of Civil Engineers, Internal structure of the earth- Composition - Plate Tectonics			
Module: 2	**Minerals and Rocks**	**4 hours**	**SLO: 1, 2**
Minerals, their physical properties - rock forming minerals, physical and engineering properties of igneous, metamorphic and sedimentary rocks			
Module: 3	**Weathering and Soil Formation**	**3 hours**	**SLO: 1, 2**
Rock decay and weathering, soil origin and formation – classification and its engineering importance, slope stability			
Module: 4	**Geological Structures**	**4 hours**	**SLO: 2, 9**
Geological Structures - Folds, Faults and Joints – Engineering Considerations involves Structures.			
Module: 5	**Geological Hazards**	**6 hours**	**SLO:2, 9**
Brief description on geological hazards -cause and formation of flood, cyclone, Volcano, Landslides and earthquake – Remedial Measures. Geological Considerations for Dam Reservoirs, Tunnels and Road construction			
Module: 6	**Ground Water**	**4 hours**	**SLO:1, 2, 9**
Characteristic of ground water, hydrogeological cycle, types of aquifers, water level fluctuations, surface and subsurface geophysical methods, groundwater contamination, harvesting of rainwater.			
Module: 7	**Remote Sensing and GIS**	**3 hours**	**SLO: 1, 2**
Introduction to Remote sensing and Geographical Information System			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1.	Parbin Singh, Engineering & General Geology, S.K.Kataria and Sons- Delhi, 8th Edition, (2010).

Reference Books

1.	Garg,S.K., Physical and Engineering Geology, Khanna Publishers, New Delhi, (2010).
2.	Dimitri, P. Krynine and William, P. Judd, Principles of Engineering Geology and Geomechanics, CBS Publishers and Distributors, New Delhi, (2005).

3.	Garg. S.K. (2004), Physical and Engineering Geology, Khanna Publishers. – Delhi		
4.	Blyth – Edward Arnold F.G.H (1998), A Geology for Engineers, (7th Edition)		
5.	H.H.Reed and F. Rutly (1960), Elements of Mineralogy, Thomas Murby, London.		
6.	M.P.Billings (1972), Structural Geology, Prentice Hall, Eaglewood Cliffs		
7.	David. K. Todd John Wily & Sons Inc, Ground Water Hydrology (2005), 3rd Edition, New York		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	J	C
CLE1013		3	0	0	0	3
Pre-requisite	**Environmental Studies**	**Syllabus version**				
		1.1				

Course Objectives:

1. To introduce the relevant legal systems and to examine the processes by which rules are adopted and enforced
2. To develop an understanding of the use of EIA procedures and methods within the project and planning cycle to promote more sustainable forms of development
3. To promote more effective use of Environmental Management Systems and implementation of Environmental requirements.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Apply the main procedures and methods which are used at different stages in EIA process in Project Appraisal, Decision making and implementation
2. Develop on Environmental Management Systems
3. Develop Environmental law principles in the Regional and International context

Student Learning Outcomes (SLO): 2, 9, 10

Module: 1	**Environmental Impact Assessment (EIA)**	**7 hours**	**SLO: 2, 10**

Introduction, Definitions and Concepts, Rationale and Historical Development of EIA–EIA for Civil and Environmental Engineers–Environmental Impact Statement–Environmental Appraisal–Environmental Impact Factors.

Module: 2	**EIA Legislation**	**6 hours**	**SLO: 2, 10**

Criteria and Standards for Assessing Significant Impact–Risk Assessment–Enforcements of Environmental Acts, Rules and Regulations–Public Participation and Involvement.

Module: 3	**EIA Methodology**	**9 hours**	**SLO:2, 9, 10**

Defining Objectives of the Project–Consideration of Alternatives–Criteria for the Selection of EIA Methodology–EIA Methods–Screening–Scoping–Predictive Models for Impact Assessment–Mitigation, Monitoring, Auditing, Evaluation of Alternatives and Decision Making

Module: 4	**Prediction and Assessment of Impacts on Physical Environment**	**6 hours**	**SLO: 2, 9**

Geology –Soils – Minerals – Climate – Water Resources – Water Quality – Air Quality – Noise.

Module: 5	**Prediction and Assessment of Impacts on Biological Environment**	**5 hours**	**SLO:2, 9, 10**

Terrestrial Ecosystems – Wetland Ecosystems – Aquatic Ecosystems – Threatened and Endangered Species.

Module: 6	**Prediction and Assessment of Impacts on Human Resources**	**5 hours**	**SLO:2, 9, 10**

Demographics – Economics – Land Use – Infrastructure – Archaeological and Historic – Visual – Safety.

Module: 7	**Impact mitigation and monitoring**	**5 hours**	**SLO: 2, 10**

Mitigation and monitoring process of adverse impacts, Rehabilitation and public participation, Drafting of EIS, Post monitoring and management (ISO 14000 series)

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1. Environmental Impact Assessment, Larry W. Canter, 1st Edition, McGraw-Hill, Inc., 1996 (ISBN: 0-07-009767-4).
2. 'Handbook of Environmental Impact Assessment- Volume 1 & 2' authored by Judith Petts,

	Blackwell Science Ltd., 1999 (ISBN 0-632-04772-0; ISBN 0-632-04771-2).		
Reference Books			
1.	'Environmental Impact Assessment: Practical Solutions to Recurrent Problems' Edited by David P. Lawrence, John Wiley & Sons, Inc., (2013).		
2.	'Environmental Impact Assessment: A Guide to Best Professional Practices' Edited by Charles H. Eccleston, CRC Press, 2011 (ISBN: 978-1-4398-2873-1).		
3.	'Methods of Environmental Impact Assessment' Edited by Peter Morris and Riki Therivel, 3rd Edition, Routledge-Taylor & Francis Group, 2009 (ISBN: 0-203-89290-9).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Project Titles (J component) **60 hrs**

Challenging projects for an Individual or a group will be given based on the basic and advancements in the course content.

Course Code	URBAN PLANNING	L	T	P	J	C
CLE1016		3	0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the objectives and planning methods of town planning
2. To know about housing policies and schemes
3. To learn the importance of environment quality and sanitation

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the methods involved in town planning
2. Know the transport and mobility requirements for a town
3. Understand the importance of smart cities and its requirements

Student Learning Outcomes (SLO):	2, 9, 10		
Module: 1	**Introduction**	**5 hours**	**SLO: 2**

History of Town Planning - Definitions and Objectives of Planning - Examples of planned and unplanned cities - Retrofitting medieval towns and existing cities - Healthy city planning.

Module: 2	**Basic Planning Methods**	**6 hours**	**SLO: 2, 9**

Base map preparation - survey techniques - Analytical methods - region classification - Demographic methods - population forecasting. Introduction of Remote sensing, GIS and GPS in urban planning context - Regional planning

Module: 3	**Housing Development**	**5 hours**	**SLO: 2**

Policies and schemes - Housing typologies - Housing for the poor and elderly - Housing finance options –under privileged population management.

Module: 4	**Infrastructure**	**6 hours**	**SLO: 2, 10**

Planning and management of local streets, water supply, storm water drainage, municipal solid waste management systems- New possibilities for recycling.

Module: 5	**Transport And Mobility**	**7 hours**	**SLO: 2, 9**

Costs of congestion - Public and Para-transit modes (taxis and autos) - Feeder systems for the use of public transport - Non-motorized transport facilities - cycling and walking infrastructure - Integrated public transport.

Module: 6	**Environment And Public Health**	**5 hours**	**SLO: 2, 10**

Environmental Quality - Sanitation - Physical and mental health challenges in urban and sub-urban areas - Vulnerable population - Conserving natural resources

Module: 7	**Smart Cities**	**8 hours**	**SLO: 2, 9, 10**

Smart city developments across the world - Specific priorities for Smart Cities in India - Leveraging recent technologies in enhancing urban living: internet of things (IoT) - Recreation -Renewable energy - Green corridors, green space and green buildings - Safety and security of urban population.

Module: 8	**Contemporary issues**	**3 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1.	Peter Hall, Mark Tewdwr-Jones, Urban and Regional Planning. Taylor & Francis, (2010).

Reference Books

1.	Peter Hall, Cities of Tomorrow: An Intellectual History of Urban Planning and Design Since 1880. 4th Edition, Wiley-Blackwell, (2014).
2.	Randall Crane and Rachel Weber, The Oxford Handbook of Urban Planning. Oxford University Press, (2012)

3.	Ian Bracken, Urban Planning Methods: Research and Policy Analysis. Routledge, Taylor & Francis, (2009).
4.	Harry T. Dimitriou, Ralph Gakenheimer, Urban Transport in the Developing World: A Handbook of Policy and Practice. Edward Elger, USA, (2011).
5.	Joy Sen., Sustainable Urban Planning. The Energy and Resources Institute, New Delhi, India, (2013).
6.	Russ Lopez., The Built Environment and Public Health. John Wiley & Sons, (2012).
7.	Eddie N. Laboy-Nieves, Fred C. Schaffner, Ahmed Abdelhadi, Mattheus F.A. Goosen. Environmental Management, Sustainable Development and Human Health. CRC Press, Taylor & Francis, (2008).
8.	Carol L. Stimmel, Building Smart Cities: Analytics, ICT, and Design Thinking. CRC Press, Taylor & Francis, (2015).
9.	Durganand Balsavar, Mahindra World City, Public Private Partnerships in Urban Planning, Mapin Publishers, (2012).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	23.11.2016		
Approved by Academic Council	43rd ACM	Date	12.12.2016

Course Code	ADVANCED CONCRETE TECHNOLOGY	L	T	P	J	C
CLE2007		3	0	2	4	5
Pre-requisite	**CLE1007 Construction Materials and Techniques**	**Syllabus version**				
		1.0				

Course Objectives:

1. To know the types of cement, mineral and chemical admixtures, aggregates
2. To understand the properties of concrete.
3. To know the methodology of mix design**.**

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the suitability of materials for the construction works.
2. Implement the special concreting methods required for Cold weather and hot weather regions.

Student Learning Outcomes (SLO):	1, 6, 14

Module: 1	**Concrete Ingredients**	**6 hours**	**SLO: 1, 6, 14**

ASTM classification of Cement - Manufacturing - Types of cement - Properties of Cement - Testing of Cement - Fine aggregates and coarse aggregates- Properties and testing-process of hydration

Module: 2	**Properties of Concrete**	**6 hours**	**SLO: 1, 6, 14**

Selection of materials for concrete - water cement ratio - Properties of fresh concrete - workability - measurement of workability - Admixtures - process of various stages of concrete - Statistical and quality control of concrete.

Module: 3	**Mechanical properties of concrete**	**6 hours**	**SLO: 1, 6, 14**

Strength of concrete - gain of strength with age - testing of hardened concrete - Compressive strength - Tensile strength - Flexural strength - modulus of elasticity of concrete - Stress and Strain characteristics.

Module: 4	**Non-destructive techniques**	**6 hours**	**SLO:1, 6, 14**

Rebound hammer and ultrasonic Pulse Velocity test - Corrosion rebar test.

Module: 5	**Mix Design**	**6 hours**	**SLO: 1, 6, 14**

Concrete mix design - concepts of mix design - variables in proportioning - Different methods of mix design - Indian Standard method IS 10262.

Module: 6	**Durability of concrete**	**6 hours**	**SLO:1,6, 14**

Permeability of concrete - Shrinkage-plastic shrinkage - drying shrinkage - Chemical attack - Sulphate attack of concrete structures - chloride attack.

Module: 7	**Special Concretes**	**6 hours**	**SLO: 1, 6**

High performance concrete - high strength concrete, high density concrete - light weight concrete - Fibre reinforced concrete - self-compacting concrete - Polymer concrete.

Module: 8	**Contemporary issues**	**3 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1. Gambir M. L, Concrete Technology, Tata MC-Graw Hill-Education, 2013.
2. Shetty M.S., Concrete Technology, S. Chand & Company Ltd., 2010
3. Metha P.K, "Concrete: Microstructure, properties and Materials", McGraw-Hill, 2014.

Reference Books

1. Zongjin Li, Advanced Concrete Technology, John Wiley & Sons – 2011
2. IS : 12269-1987, Specification for 53 grade ordinary Portland Cement, BIS, New Delhi.

3.	IS : 383 – 1970, Specification for Coarse and fine natural sources for Concrete, BIS, New Delhi.		
4.	IS:10262-2009, Concrete Mix Proportioning - Guidelines.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Advanced Concrete Technology Lab

Sl. No.	Laboratory Exercises	Hrs	SLO
1.	Tests on various properties of the ingredients of concrete: Cement	30	14
2.	Tests on various properties of the ingredients of concrete: Fine aggregate		
3.	Tests on various properties of the ingredients of concrete: Coarse aggregate		
4.	Workability tests on concrete: Slump Cone test, Compaction factor test and Consistency test (VB Consistometer)		
5.	Mechanical properties of concrete: Casting of concrete cube, cylinder specimens, curing and testing.		
6.	Study on the fresh state properties of the special concrete: Self-Compacting concrete		
7.	Tests for assessing the performance of hardened concrete finding its Stress-strain relationship, Young's Modulus.		
8.	Non-destructive Testing: Existing Beam, column & slabs		

Sample project titles for J - Component

Project Titles	L Hr
1. Experimental study on mechanical properties of Steel fiber concrete 2. Comparative study on natural and synthetic fiber concrete 3. Experimental study on flexural behavior of light weight concrete 4. Rheological properties of Self compacting concrete 5. Flexural behavior of geo-polymer concrete 6. Durability study on geo-polymer concrete 7. Durability studies on bottom ash concrete 8. Creep and shrinkage studies on natural fiber concrete 9. Creep and shrinkage studies on synthetic fiber concrete 10. Durability studies on recycled aggregate concrete 11. Durability studies on self compacting concrete 12. Study the influence of chemical and mineral admixture on mechanical properties of concrete	60

Course Code	CONSTRUCTION PLANNING AND MANAGEMENT	L	T	P	J	C
CLE2008		3	0	0	0	3
Pre-requisite	**CLE1007 Construction Materials and Techniques**	**Syllabus version**				
		1.1				

Course Objectives:

1. To make the students understand the principles of management
2. To learn the construction planning and types of project
3. To know about the time estimate in the construction activities

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the principles of management and safety procedure in construction
2. Know the procedures in accounts and stores in construction activities
3. Perform the CPM and PERT analysis

Student Learning Outcomes (SLO):	2, 9, 10, 15

Module: 1	**Principles of Management**	**5 hours**	**SLO: 2**

Definition - Importance – Functions of Management - Relevance to government and Quasi Government departments - Private Contractors - Contracting firms - Organizational structure. Construction safety measures.

Module: 2	**Construction Planning and Labour Welfare**	**8 hours**	**SLO: 2, 10**

Collection of field data - Preliminary estimates - Approval and sanction of estimates - Budget provisions - Relationships between management and labour - Problems - Labour legislations - Minimum Wages act - Industrial Psychology - Safety procedures in construction.

Module: 3	**Projects**	**7 hours**	**SLO:2, 9, 15**

Tendering - Arbitration - International projects - Detailed Project Reports (DPR) / Build Own Operate (BOO) / Build Own Operate Transfer (BOOT) Projects / Build Operate and Transfer (BOT) - case studies.

Module: 4	**Accounts and Stores**	**6 hours**	**SLO:2, 10**

Measurements of work - Checking - Types of bills - Mode of payment - Claims - Banking settlements - Types of accounts - Cash book - Storing - Maintenance Inspection - Inventories - Transfer of surplus and accounting of shortage stores - Procedures adopted in PWD and CPWD.

Module: 5	**Network element and development of Network**	**7 hours**	**SLO:2, 9**

Introduction - Event - Activity - Dummy - Network rules - Graphical guidelines for network - Common partial situations in network - Numbering the events - Cycles Problems - Planning for network construction - Modes of network construction - Work breakdown structure Hierarchies.

Module: 6	**CPM**	**5 hours**	**SLO:2, 9**

Introduction - Slack - Critical Path - Example problem - Activity time estimate - Earliest event time - Latest allowable occurrence time - Combined tabular computations for TE and TL - Start and finish time of activity - Float - Critical activity and Critical path - Problems.

Module: 7	**PERT**	**5 hours**	**SLO: 2, 9**

Introduction - Use of PERT - Time estimate - Frequency distribution - Mean, Variance and standard deviation - Probability distribution - Expected time problem - Example problems.

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**45 hours**	

Text Book(s)

1. Chitkara, K.K "Construction Project Management Plan, Se (English) 2nd Edition, Tata Mcgraw Hill Education Private Limited, 2010.

2.	Sharma, J.L, “Construction Management and accounts” Satya Publications, 2013.		
Reference Books			
1.	Prasad, L.M “Principles of Management”, Sultan Chand & sons, New Delhi, 2012.		
2.	Stephen Robbins, “Organizational Behavior”, Pearson Education, New Delhi, 2011.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	ADVANCED SOIL MECHANICS	L	T	P	J	C
CLE2009		2	2	0	0	3
Pre-requisite	**CLE1004 Soil Mechanics & Foundation Engineering**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the soil composition and structure
2. To learn the stress-strain relationship
3. To know about the slope stability and its analysis

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the soil properties and its interaction with air and water
2. Learn about the shear strength and related analysis of soil
3. Perform the geotechnical physical modeling

Student Learning Outcomes (SLO):	2, 9, 14

Module: 1	**Soil Composition And Soil Structure**	**5 hours**	**SLO: 2**

Soil formation; Types of soils and their characteristics; Particle sizes and shapes; their impact on engineering properties;
Soil structure; Clay mineralogy; Different types of bonding in clay minerals, Soil-air-water interaction.

Module: 2	**Seepage and Flow Nets**	**3 hours**	**SLO: 2, 9**

Permeability; Seepage force and effective stress during seepage.
Laplace equations of fluid flow, Flow nets, Anisotropic and non-homogeneous medium, Confined and Unconfined seepage.

Module: 3	**Compressibility and Consolidation**	**3 hours**	**SLO: 2, 9, 14**

Stresses in soil from surface loads; Terzagahi's 1-D consolidation theory; Application in different boundary conditions. Normally and Over consolidated soils; Compression curves; Secondary consolidation. Radial consolidation; Settlement of compressible soil layers and Methods for accelerating consolidation settlements.

Module: 4	**Stress-Strain Relationship**	**3 hours**	**SLO: 2**

Stress state, Mohr's circle analysis and Pole, Principal stress space, Stress paths in p-q space; Isotropic compression and pressure dependency, confined compression, large stress compression, Drainage conditions.

Module: 5	**Shear Strength of Soils**	**4 hours**	**SLO:2, 14**

Triaxial behaviour, stress state and analysis of UC, UU, CU, CD, and other special tests, Skempton pore pressure parameters.

Module: 6	**Stability of Slopes**	**4 hours**	**SLO:2, 9, 14**

Stability analysis of infinite slopes; Finite slopes – Swedish circle method, Friction circle method and Taylors stability chart; Methods for enhancing stability of unstable slopes.

Module: 7	**Geotechnical Physical Modeling**	**6 hours**	**SLO: 2, 9**

Physical modeling methods; Application of centrifuge modeling and its relevance to geotechnical engineering; Centrifuge modeling of geotechnical structures.

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Das, B.M. Advanced Soil Mechanics. Taylor and Francis Group, London, Second edition, (2013).

Reference Books

1.	Wood, D.W., Geotechnical Modelling Spon Press, Taylor and Francis Group, London, First edition, (2007).

2.	Powrie, W., Soil Mechanics concepts and applications. Spon Press, Taylor and Francis Group, London, Second edition, (2009).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	GROUND IMPROVEMENT TECHNIQUES	L	T	P	J	C
CLE2010		2	0	0	4	3
Pre-requisite	**CLE1004 Soil Mechanics & Foundation Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To give an overview of latest ground improvement techniques
2. To understand the problems related to soil and select the best suitable method for improvement

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the problems in Expansive soils
2. Implement the stabilization methods
3. Apply grouting and dewatering techniques

Student Learning Outcomes (SLO): 2, 5, 9

Module: 1	**Introduction**	**3 hours**	**SLO: 2**
Different types of problematic soils and their geological formation principles of treatment-loading.			
Module: 2	**Treatment of Loose Sands**	**5 hours**	**SLO: 2, 9**
Compaction piles, dynamic compaction, vibroflot technique, controlled blasting for compaction.			
Module: 3	**Grouting Techniques**	**4 hours**	**SLO: 2, 5, 9**
Permeation grouting, Compaction technique, jet grouting, different varieties of grout materials, grouting in difficult conditions.			
Module: 4	**Treatment of Expansive Soils**	**5 hours**	**SLO: 2, 9**
Physical and chemical stabilization injection method, lime-columns.			
Module: 5	**Accelerated Consolidation Methods For Soft Clay Soils**	**5 hours**	**SLO: 2, 5, 9**
• Sand drains. • Pre-fabricated drains. • Stone columns			
Module: 6	**Geosynthetics**	**3 hours**	**SLO:2**
Concepts -materials, Types and application of reinforced earth – Introduction to Geosynthetics -geo-textiles-separation and road work – Case studies			
Module: 7	**Dewatering Techniques**	**3 hours**	**SLO: 2, 9**
Introduction-Well points-Vaccum / electro osmatic methods			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Hausmann, H.R. "Engineering Principles of Ground Modification", McGraw-Hill Book Company. 3rd Edition 2010.

Reference Books

1.	P. Purushotamaraj “Ground Improvement Techniques”, Laxmi Publications (P) Ltd. 2016.
2.	Gulati and Datta "Geotechnical Engineering", Tata McGraw Hill. 2017.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sample Projects for J component **60 hrs**

1. Stabilization of soft clays using admixtures.
2. Stabilization of expansive soils using chemical stabilization.
3. Analysis and behavior of stone columns using PLAXIS.
4. Use of synthetic fibres in soil stabilization.
5. Use of natural fibers in soil stabilization.
6. Laboratory study on use of geosynthetics.
7. Consolidation studies using drains
8. Study on vacuum consolidation
9. Slope protection measures
10. Stability analysis of natural and man-made slopes

Course Code	SOIL DYNAMICS AND MACHINE FOUNDATION	L	T	P	J	C
CLE2011		2	2	0	0	3
Pre-requisite	**CLE1004 Soil Mechanics and Foundation Engineering**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the fundamentals of vibration
2. To learn the dynamic properties of soil
3. To analyze and design machine foundation

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the wave propagation and dynamic properties of soil
2. Perform analysis and design of machine foundation

Student Learning Outcomes (SLO):	1, 2, 5

Module: 1	**Fundamentals of Vibration**	**4 hours**	**SLO: 1, 2**

Introduction, Sources of vibrations, Basics concepts of vibration, classification of vibrations, Vibration analysis procedure, Simple harmonic motion. Undamped free vibration of SDOF systems
Damping: Linear, Non-linear damping, Equivalent viscous damping. Damped free vibration of SDOF systems. Response of damped SDOF system under harmonic force and rotating unbalanced force.

Module: 2	**Wave Propagation in Elastic Medium**	**4 hours**	**SLO: 1, 2**

Shear and Dilational waves, Rod waves – Natural frequencies and mode shapes, Rayleigh waves and their significance in soil dynamics, attenuation of shear waves.

Module: 3	**Dynamic soil properties**	**3 hours**	**SLO:1, 2**

Dynamic soil properties - Gmax, Gsec, Gtan, G/Gmax and damping. Factors affecting dynamic soil properties.
Lab tests: Resonant column test, Bender element test, cyclic triaxial / simple shear / Torsional shear tests
Field tests: Seismic reflection and refraction tests, Seismic crosshole and downhole tests, SASW/MASW tests, Block vibration test, Cyclic Plate load test, SPT and DCPT.

Module: 4	**Soil modeling for cyclic loading**	**6 hours**	**SLO:1, 2**

Linear viscoelastic model – stress-strain relationship – Kelvin model – Maxwell model. Nonlinear stress-strain model – Hyperbolic model, Masing model, Ramberg-Osgood model.

Module: 5	**Dynamic stiffness of shallow foundations**	**3 hours**	**SLO:1, 2, 5**

Circular rigid mat foundation on elastic half space excited vertically, laterally, torsion or rocking – Effective stiffness and damping of such systems.
Effect of foundation shape and embedment on stiffness and damping constants
Finite soil layer and depth to bedrock on system of rigid foundations

Module: 6	**Vibration Isolation**	**3 hours**	**SLO: 1, 2**

Principles of vibration isolation – Active and Passive Isolation, Methods of isolation, Design of wave barriers.

Module: 7	**Analysis and Design of Machine Foundations**	**5 hours**	**SLO: 2, 5**

Block foundations for reciprocating engines and low speed rotary machines, Block foundations for forge hammers and other impact machines, Frame foundations for high speed rotary machineries, Spring mounted foundations.

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)			
1.	Das B.M and Ramanna G.V., Principles of soil dynamics 2nd Edition, Cengage learning, Stanford, USA, (2011).		
Reference Books			
1.	K.G. Bhatia, Foundations For Industrial Machines, D-CAD Publishers, (2008).		
2.	Kramer, S. L., Geotechnical Earthquake Engineering, Pearson Education Inc., New Delhi, (2010).		
3.	Prakash, S. and Puri, V. K., Foundation for machines: Analysis and Design, John Wiley & Sons, New York, (2008).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	ADVANCED FOUNDATION ENGINEERING	L	T	P	J	C
CLE2013		2	2	0	0	3
Pre-requisite	**CLE1004 Soil Mechanics and Foundation Engineering**	**Syllabus version**				
		1.1				

Course Objectives:

1. To learn about advanced methods for soil exploration
2. To understand and design different types of foundations
3. To study the retaining walls and its design

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the suitable method for soil exploration
2. Design suitable foundation based on soil characteristics
3. Understand the design considerations for retaining walls

Student Learning Outcomes (SLO):	2, 5, 6

Module: 1	**Advanced soil exploration methods**	**4 hours**	**SLO: 2**
Introduction, Cone penetration test, Pressure meter test, Dilatometer test, Geophysical exploration methods.			
Module: 2	**Shallow Foundations**	**4 hours**	**SLO: 2, 5, 6**
Introduction, Bearing capacity - correction factors, Eccentrically loaded foundations, closely spaced foundations, bearing capacity of layered soils, combined footing.			
Module: 3	**Pile Foundation**	**5 hours**	**SLO: 2, 5, 6**
Methods of construction of bored cast-insitu pile, Pile installation, Laterally loaded piles and different types of load tests on piles. Application of stress-wave theory.			
Module: 4	**MAT Foundation**	**4 hours**	**SLO: 2, 5, 6**
Introduction, rigid and flexible mat, Bearing capacity, Differential settlement, buoyancy raft, structural design of mat foundations.			
Module: 5	**Well Foundations**	**4 hours**	**SLO: 2, 5, 6**
Types, components, construction methods, design methods (Terzaghi, IS and IRC approaches), check for stability, base pressure, side pressure and deflection.			
Module: 6	**Retaining Walls**	**3 hours**	**SLO: 2, 5, 6**
Design of gravity and cantilever walls, design of cantilever and anchored sheet pile walls. Support systems for flexible retaining walls – anchors, struts, construction methods, stability calculations. Construction of diaphragm walls, barrettes, caissons, soldier piles and lagging.			
Module: 7	**Reinforced Earth**	**4 hours**	**SLO: 2, 5, 6**
Geotechnical properties of reinforced soil, shallow foundation on soil with reinforcement, retaining walls with reinforcements, design considerations.			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1. Swamisaran, Reinforced soil and its Engineering applications, I.K. International Pvt. Ltd., (2010).

Reference Books

1. Braja. M. Das. Principles of Foundation Engineering, 2011, Cengage Learning. 7th Edition, (2010).
2. J. E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Company, 5th Edition (2013).

3.	Purushothama Raj. Soil Mechanics & Foundation Engineering, darling Kindersley publishing, (2011).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	GEOTECHNICAL EARTHQUAKE ENGINEERING	L	T	P	J	C
CLE2014		2	0	0	4	3
Pre-requisite	**CLE1004 Soil Mechanics and Foundation Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To give an overview of ground motion
2. To understand the dynamic properties of soil and liquefaction phenomena

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the seismic hazard
2. Perform site response analysis
3. Learn soil improvement techniques

Student Learning Outcomes (SLO):	2, 14, 17

Module: 1	**Introduction to Geotechnical Earthquake Engineering**	**3 hours**	**SLO: 2**
Seismic hazard Seismology and Earthquakes-Nature and types of earthquake loading-Wave Propagation			
Module: 2	**Strong Ground Motion**	**4 hours**	**SLO: 2**
Introduction-Strong ground motion-Ground motion parameters-Estimation of ground motion parameters-Spatial variability of ground motions			
Module: 3	**Seismic Hazard Analysis**	**4 hours**	**SLO: 2, 14**
Introduction-Identification and Evaluation of Earthquake Sources-Deterministic Seismic Hazard Analysis-Probabilistic Seismic Hazard Analysis			
Module: 4	**Dynamic properties of soil**	**5 hours**	**SLO:2, 14**
Dynamic soil properties- Factors affecting dynamic soil properties. Lab tests: Cyclic triaxial / simple shear / Torsional shear tests Field tests: Block vibration test, Cyclic Plate load test.			
Module: 5	**Liquefaction related Phenomenon**	**4 hours**	**SLO:2**
Types of Liquefaction-Evaluation of Liquefaction hazard-Liquefaction Susceptibility-Initiation of Liquefaction-Effects of Liquefaction			
Module: 6	**Site Response Analysis**	**4 hours**	**SLO:2, 14**
Ground Response Analysis - Linear, Equivalent linear and Non-linear approach- Site Classification			
Module: 7	**Soil Improvement**	**4 hours**	**SLO: 2, 14, 17**
Densification Technique-Reinforcement Techniques-Grouting Techniques-Drainage Techniques-Verification of soil improvement			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall, (2013)

Reference Books

1. B. N. Das and Ramana, "Principles of Soil Dynamics", Cangage Learning, 2nd edition (2011)

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Project Titles (J component) **60 hrs**

Challenging projects for Individual or a group will be given based on the basic and advancements in the course content.

Course Code	HYDRAULIC STRUCTURES AND MACHINERY	L	T	P	J	C
CLE2015		2	2	2	0	4
Pre-requisite	**MEE1004 Fluid Mechanics**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the working principles of hydraulic machinery
2. To study the various structures designed for storage and for the development of irrigation system.
3. To know the irrigation structures and its applications

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the pump required for different purposes
2. Classify the turbines and explain design criteria based on water availability
3. Design the head work and escape in an irrigation system
4. Design the drops and outlet for the canal system

Student Learning Outcomes (SLO): 1, 5, 9, 14

Module: 1	**Impact of Jet on Vanes and Turbines**	**5 hours**	**SLO: 1, 14**
Impact of Jet on flat and curved vanes, Classification - Pelton Turbine, Francis Turbine, Kaplan Turbine-Velocity Triangle, Characteristic Curves, Specific Speed -Governing of Turbines.			
Module: 2	**Pumps**	**5 hours**	**SLO: 5, 14**
Centrifugal Pump-Velocity triangle, characteristic curves, specific speed. Reciprocating pump – Types – Indicator diagram-Acceleration and friction, air vessels.			
Module: 3	**Diversion Head work**	**5 hours**	**SLO: 5, 9**
Weir and Barrage – Gravity and Non –gravity weir- Layout of a diversion head works and its components – Under sluice –Divide wall- River training works- fish ladder			
Module: 4	**Theories of seepage and Design of weir**	**3 hours**	**SLO: 5, 9**
Failure of hydraulic structure- Bligh's creep theory – Lane's weighted creep theory- Design of Vertical drop weir on Bligh's theory – Basic cutoff walls.			
Module: 5	**Regulators and Modules**	**3 hours**	**SLO: 5, 9**
Canal regulation works –Distributary Head regulator and cross regulator- Types of canal escapes – Types of outlets (Modules)- cross drainage works			
Module: 6	**Reservoirs**	**2 hours**	**SLO: 1, 9**
Reservoir types- storage capacity, storage zones, Sedimentation- causes, effect & control measures.			
Module: 7	**Dams and Hydro- electric power structures**	**5 hours**	**SLO: 1, 9**
Dams, factors governing their selection-Classification, Elementary design of gravity dam - - spill ways, energy dissipators, spill way gates, Classification of hydel plants- Principal components of a hydro-electric scheme- water hammer- remedies			
Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1. Bansal R.K, (2010) " Fluid mechanics and hydraulic machines" Lakshmi Publishers, New Delhi
2. Santosh kumar Garg (2012) "Irrigation Engineering and Hydraulic Structures" Khanna Publisher

Reference Books

1. Das M.M Fluid Mechanics and Turbo machines, Prentice Hall of India (P) Ltd New Delhi, (2012).
2. Arore, K.R Fluid Mechanics, Hydraulic and Hydraulic Machines , Standard Publishers and Distributors , New Delhi, (2011).

3.	PN Modi, “Irrigation water resources and water power engineering” standard book house 9th edition, (2011).		
4.	Dr J. F. Douglas , Dr J. M. Gasoriek , Prof John Swaffield , Lynne Jack, “Fluid Mechanics” Pearson Fifth edition, (2010).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory	L Hr	SLO
1. Statistical and error analysis of centrifugal pump 2. Determine the flow ratio for jet impingement on vanes for different types of vanes 3. Performance characteristics curve for pump in series and pump in parallel. 4. Prediction of design head and design discharge of self-priming pump 5. Determination slip of reciprocating pump 6. Performance of main characteristics of a Gear Pump 7. Performance operating characteristics of a Submersible pump 8. To determine iso-efficiency curves for Pelton turbine 9. Load test on Francis Turbine 10. Characteristics test on Kaplan Turbine	**30**	**14**

Course Code	HYDROLOGY	L	T	P	J	C
CLE2017		3	0	0	0	3
Pre-requisite	**MEE1004 Fluid Mechanics**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the planning and construction of irrigation structures
2. To have an idea about the construction of culverts and bridges
3. To understand the measures of flood control

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know the precipitation potential & analysis of precipitation data
2. Get exposure about the stream flow measurements & runoff computations
3. Implement the hydraulic principles involved as well as its applications to engineering problems

Student Learning Outcomes (SLO):	2, 7, 9

Module: 1	**Introduction**	**5 hours**	**SLO: 2, 7, 9**

Hydrologic cycle, hydrologic system model, Water budget: analysis and synthesis, atmospheric circulation.

Module: 2	**Precipitation**	**8 hours**	**SLO: 2, 7, 9**

Formation of precipitation – types of precipitation – Precipitable water – Precipitation in a cloud system - Rainfall measurement and characteristics – Estimating missing rainfall data – Rain gauge consistency – Average annual rainfall – Development of a design storm – probable maximum precipitation

Module: 3	**Watershed Characteristics**	**5 hours**	**SLO: 2, 7**

Watershed definition and delineation - Watershed geomorphology – channel geomorphology – travel time estimation

Module: 4	**Hydrologic Abstractions**	**6 hours**	**SLO: 2, 7, 9**

Infiltration: Definition and factors affecting infiltration – Infiltration Estimation: Horton's model, Green-Ampt Model, Infiltrometer, SCS Method. Evaporation and Transpiration: Definition, factors affecting evaporation, methods for estimation of evaporation – EPT: Definition, estimation of EPT

Module: 5	**Unit Hydrograph**	**8 hours**	**SLO: 2, 9**

Sources of streamflow, streamflow hydrograph and hydrograph characteristics, excess rainfall and direct runoff, Abstractions: Using infiltration indices and SCS method – Peak discharge
Unit hydrograph: Definition, Assumptions and Limitations, UH derivation and Application, S-Hydrograph, Synthetic UH, UH for different rainfall durations

Module: 6	**Frequency Analysis**	**5 hours**	**SLO:2, 7, 9**

Return period, extreme value distributions, Frequency analysis using frequency factors, Probability plotting – Risk Assessment

Module: 7	**Hydrologic Design**	**5 hours**	**SLO: 2**

Design Storms: Design precipitation depth, IDF curves, Design precipitation hyetographs from IDF curves, Calculation of probable maximum precipitation. Design Flows: Simulating design flows, flood plain analysis, flood forecasting

Module: 8	**Contemporary issues**	**3 hours**	**SLO: 2, 7, 9**
Total Lecture hours		**45 hours**	

Text Book(s)

1. VenTe Chow, David R Maidment, Larry W. Mays, Applied Hydrology. McGraw Hill International Editions, (2010)

2.	Subramanya, Engineering Hydrology, Tata McGraw Hill Co., Graw Hill Co., (2010).		
Reference Books			
1.	Hydrology and Water Resources Engineering, S.K. Garg, JBA publishers, (2015)		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	INDUSTRIAL WASTES TREATMENT AND DISPOSAL	L	T	P	J	C
CLE2018		2	0	0	4	3
Pre-requisite	**CLE1006 Environmental Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To know the various sources of industrial pollutants and its effect on environment.
2. To understand various processes of industrial liquid and solid waste treatment.
3. To provide adequate knowledge about sources, characteristics and treatment processes of different types of industries.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the sources and effects of industrial pollution.
2. Select suitable treatment techniques for industrial waste treatment.
3. Use clean technologies for industrial waste management.

Student Learning Outcomes (SLO):	2, 9, 10

Module: 1	**Sources and types of Industrial wastes**	**3 hours**	**SLO: 2**
Liquid, solid, and gaseous waste - effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health			
Module: 2	**Recent trends in Industrial waste management**	**3 hours**	**SLO: 2, 9, 10**
Cradle to Grave concept - life cycle analysis - clean technologies			
Module: 3	**Treatment of specific pollutants in industrial waste**	**4 hours**	**SLO: 2, 9**
Fluoride – cyanide - Toxic organics - Heavy metals - Radioactivity			
Module: 4	**Liquid Waste Treatment**	**6 hours**	**SLO:2, 9**
Equalization – Neutralization – Modern treatment techniques: removal of suspended and dissolved organic solids - Removal of dissolved inorganic solids			
Module: 5	**Industrial Solid Waste Treatment**	**6 hours**	**SLO:2, 9, 10**
Physico-chemical treatment – solidification – incineration – Secured landfills – Legal Provisions			
Module: 6	**Gaseous pollutant treatment**	**3 hours**	**SLO:2,9**
Absorption – scrubbing – catalytic oxidation – thermal treatment			
Module: 7	**Various Industrial Pollution Control**	**3 hours**	**SLO: 2, 9**
Treatment processes of selected industries- textiles, tanneries, dairy, sugar, paper, distilleries, steel plants, refineries, fertilizer and thermal power plants.			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. V. V. Ranade, V. M. Bhandari, Industrial Wastewater Treatment, Recycling and Reuse, Elsevier Publications, 2014.
2. W. Wesley Eckenfelder, Davis L. Ford, Andrew J. Englande, Industrial Water Quality, 4th Ed. Tata McGraw 2009.

Reference Books

1. Patwardhan A.D, Industrial Waste Water Treatment, PHI Learning Private Limited-New Delhi (2009)
2. Arcievala, S.J., "Wastewater Treatment for Pollution Control", Tata McGraw Hill, (2006)
3. Nelson, L. Nemerow, Liquid Waste of Industry, Theories, Practices and Treatment, Addison-Wesley Publishing Company, London, (2008).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Project Titles (J component) **60hrs**

Challenging projects for Individual or a group will be given based on the basic and advancements in the course content.

Course Code	POLLUTION CONTROL AND MONITORING	L	T	P	J	C
CLE2019		2	0	0	4	3
Pre-requisite	**CLE1006 Environmental Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the sources, effects and control methods of air pollution, water pollution and noise pollution.
2. To know about the environmental legislations
3. To learn the municipal solid waste management and environmental sanitation.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know the environmental legislations in India.
2. Indicate the techniques for water, air and noise pollution control.
3. Know the approach for municipal solid waste management and environmental sanitation.
4. Use the advanced methods for monitoring the pollution.

Student Learning Outcomes (SLO):	2, 6, 10

Module: 1	**Pollution: An overview**	**4 hours**	**SLO: 2, 6, 10**
Pollution control regulations of India: water, air, noise, solid and hazardous waste- Agencies involved and structure of implementation.			
Module: 2	**Water Pollution**	**4 hours**	**SLO: 2, 6, 10**
Natural process of self- purification in water- BOD consideration in streams – Oxygen Sag Curve- pollution due to industrial, agricultural and municipal wastes- need of water pollution control.			
Module: 3	**DWWT and ZLD**	**3 hours**	**SLO:2, 6, 10**
Concept of decentralized wastewater treatment (DWWT) and reuse. Zero liquid discharge (ZLD) from industries and recycle.			
Module: 4	**Air Quality Control**	**4 hours**	**SLO:2, 6, 10**
Air quality criteria and standards- Elements of regulatory and non-regulatory control-Strategies-Indoor air quality.			
Module: 5	**Noise Pollution**	**4 hours**	**SLO: 2, 10**
Environmental community noise- Measures for prevention and control of noise – Industrial noise and control -Noise measurement and mapping-			
Module: 6	**Municipal Solid Waste Management**	**4 hours**	**SLO:2,6,10**
Source characteristics – quantities – collection methods and disposal techniques – sanitary landfill – incineration – and pyrolysis, composting- recycling and reuse.			
Module: 7	**Environmental Sanitation**	**4 hours**	**SLO: 2, 10**
Personal Hygiene and Sanitary Food Handling-Rural and urban sanitation-Traditional and modern methods.			
Module: 8	**Contemporary issues**	**3 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. Peavy, H.S., Rowe, D.R and George Tcnobanoglous, Environmental Engineering, Mc-Graw Hill company, New Delhi, (2010).
2. Rao C. S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, (2007).

Reference Books			
1.	Environmental Pollution Monitoring and Control, S.M. Khopkar, New age International (P) Ltd publishers, (2010).		
2.	Environmental Pollution and Control, P. R. Trivedi, JBA publishers, (2008)		
3.	Environmental Pollution and Control in Chemical Process Industries, S. C. Bhatia, JBA publishers 2nd Edition, Reprint (2014).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sample projects for J component (minimum of 60 hours of work by group of students)
Wastewater collection from various sources and its characterization and design the appropriate water pollution control units. Study the water pollution status of India/states and identify the sources of pollution and suggest the appropriate water pollution control measures. Studies and report preparation of DWWT practiced in a community Studies and report preparation of ZLD practiced in an industry Ambient air quality monitoring of a selected site Development of air quality index of a selected town/city Studies and report preparation of air pollution control in an industry Studies and report preparation of noise pollution control in an industry Studies and report preparation of noise pollution control in National Highways Studies and report preparation of solid waste management practiced in a community

Course Code	SOLID WASTE MANAGEMENT	L	T	P	J	C
CLE2020		2	0	0	4	3
Pre-requisite	**CLE1006 Environmental Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the sources, characteristics of municipal solid waste
2. To learn the collection, transport and disposal of municipal solid waste
3. To know the possibilities for recover of materials and energy from waste.
4. To understand the management of hazardous waste

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know the possibilities of energy recovery from waste
2. Select the approach for treatment and disposal of hazardous waste
3. Understand the legislations for waste management

Student Learning Outcomes (SLO):	2, 9, 10

Module: 1	**Municipal Solid Waste Management: An Overview**	**6 hours**	**SLO: 2, 10**

Definition of solid waste –major legislation, monitoring responsibilities, Effects of improper disposal of solid wastes – public health effects
Sources and types of solid waste – sampling and characterization – Determination of composition of MSW – storage and handling of solid waste.
Collection and Transport of Solid Waste: Waste collection systems– alternative techniques for collection system. Need for transfer operation, transport means and methods.

Module: 2	**Municipal solid waste treatment: Materials Recovery**	**4 hours**	**SLO: 2, 9, 10**

Unit operations for separation and processing, Materials Recovery facilities on site/off site, Composting process

Module: 3	**Municipal Solid waste treatment: Energy Recovery**	**3 hours**	**SLO:2, 9, 10**

Anaerobic digestion, RDF and Incineration and co-generation of energy using waste, Pyrolysis of solid waste

Module: 4	**Disposal of municipal Solid wastes**	**5 hours**	**SLO:2, 9, 10**

Dumping of solid waste; sanitary landfills – site selection, design and operation of sanitary landfills – Leachate collection & treatment

Module: 5	**Recyclable solid waste materials for civil engineering applications**	**3 hours**	**SLO: 2, 9, 10**

Construction debris, fly ash, gypsum, red mud, blast furnace slag; e- waste.

Module: 6	**Principles of solid and Hazardous waste management**	**2 hours**	**SLO:2,10**

Principles of solid waste management, Definition and identification of hazardous wastes, cradle to grave management concept, Prevailing laws of in hazardous waste management. Risk assessment.

Module: 7	**Treatment and disposal of hazardous wastes (Biomedical waste, Industrial and nuclear waste)**	**5 hours**	**SLO: 2, 9,10**

Disinfection, autoclaving, incineration, Stabilization, Solidification, air stripping, oxidation, bioremediation and any other appropriate techniques

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. George Techobanoglous et al, "Integrated Solid Waste Management ", McGraw□ Hill Publication, Latest edition, (2010)
2. Charles A. Wentz; "Hazardous Waste Management", McGraw□Hill Publication, Latest publication, (1992).

Reference Books	
1.	Handbook of Solid Waste Management by Frank Kreith , George Tchobanoglous, McGraw Hill Publication, (2002).
2.	Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience, ISBN: 0□471□30681□9.
3.	Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, (2000).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sample syllabus with J component (minimum of 60 hours of work by a group of students)
List of sample project topics Collection and characterization of solid and hazardous waste Devise appropriate treatment options based on varying characteristics Route optimization studies for collection of solid waste Economic appraisal of a selected waste management scheme

Course Code	ECONOMICS AND BUSINESS FINANCE FOR CIVIL ENGINEERS	L	T	P	J	C
CLE2022		3	0	0	0	3
Pre-requisite	**CLE1007 Construction Materials and Techniques**	**Syllabus version**				
		1.0				

Course Objectives:

1. To bring about an exposure to construction economics, financing and accounting methods and their usefulness in controlling constructions projects.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the elements of construction economics
2. Learn the need for financial management and means of achieving the same
3. Apply a few accounting methods

Student Learning Outcomes (SLO): 2, 12, 17

Module: 1	**Introduction**	**5 hours**	**SLO: 2**

The Scope and Method of Managerial economics - Fundamental Economics concepts - Managerial Economics with other subjects - Objectives of the Firm.

Module: 2	**Demand and Supply Analysis**	**6 hours**	**SLO: 2, 12**

Meaning, Types and Determinants - Demand estimation - Demand elasticities for decision making - Business and Economic forecasting : Qualitative and Quantitative methods - Supply analysis: Meaning, elasticities and determinants - Market equilibrium and price determination

Module: 3	**Production Economics**	**6 hours**	**SLO: 2, 12**

Production and Production function - Types - Estimation - Returns to Scale - Economies and Dis-economies of Scale and Economies of Scope. Factor Inputs - Input-Output Analysis

Module: 4	**Market Structure**	**6 hours**	**SLO:2, 12**

Perfect Competition - Imperfect Competition: Monopoly - Monopolistic - Oligopolistic Strategy, Cartels, Cournot, Kinked Demand and Price Leadership.

Module: 5	**Pricing Structure**	**7 hours**	**SLO:2, 12, 17**

Oligopolistic Rivalry \& Theory of Games - Measurement of economic concentration - Policy against monopoly and restrictive trade practices - Competition Law - Pricing Practices : Objectives - Determinants - Pricing Methods - Government Policies and Pricing

Module: 6	**Introduction to Macroeconomics**	**7 hours**	**SLO: 2**

Circular Flow of Income and Expenditures - Components of National Income and its significance - Measuring Gross Domestic Product (GDP) - Inflation and Business Cycles - Government Fiscal and Monetary Policy - Balance of payments - Foreign exchange markets

Module: 7	**Macroeconomics Model**	**6 hours**	**SLO: 2, 17**

Classical Model - Keynesian Cross Model - Investment Theory - Hybrid Model - IS-LM-BP Model

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1. Bose, D. C., "Fundamentals of Financial management", 2nd ed., PHI, New Delhi, (2010).
2. Peterson, S. J., "Construction Accounting and Financial Management", Pearson Education, Upper Saddle River, New Jersey, (2015).

Reference Books

1. Jha, K. N., "Construction Project Management, Theory and Practice", Pearson, New Delhi, (2011).

2.	Newnan, D. G., Eschenbach, T. G. and Lavelle, J. P., “Engineering Economic Analysis”, Indian Edition, Oxford University Press, (2010).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	GIS AND REMOTE SENSING	L	T	P	J	C
CLE2023		2	0	2	0	3
Pre-requisite	CLE1003 Surveying	Syllabus version				
		1.0				

Course Objectives:

1. To understand the basic concepts of remote sensing
2. To know the applications of Geographic information systems in Civil Engineering

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the basic remote sensing concepts and its characteristics
2. Perform digital image processing of satellite images
3. Use various analysis and interpretation of GIS results

Student Learning Outcomes (SLO): 2, 9, 14

Module: 1	**Basic concepts of Remote Sensing**	**4 hours**	**SLO: 2**
Introduction to Remote Sensing, Electromagnetic Spectrum and radiation, Remote Sensing Platforms, Satellite Sensors, Orbits in Remote Sensing			
Module: 2	**Sensors and Scanning Systems**	**4 hours**	**SLO: 2, 9**
Indian Remote Satellites (IRS), Spectral characteristics earth surface features i.e, vegetation, water and soil, Understanding the spectral curves to create spectral library			
Module: 3	**Digital Image processing**	**5 hours**	**SLO:2, 9, 14**
Elements of image interpretation , Concepts of digital image processing, Image registration, Feature extraction techniques, Image classification, Landuse and landcover analysis			
Module: 4	**Basic concepts of GIS**	**4 hours**	**SLO:2, 9**
Introduction to GIS, History of development of GIS, Elements of GIS - Computer hardware and software, Map reading, various maps in GIS			
Module: 5	**Spatial Analysis tools**	**4 hours**	**SLO: 2, 9, 14**
Map overlay operations, Vector and Raster data model, Data storage and database management, Spatial data analysis techniques			
Module: 6	**Introduction and Principles of Photogrammetry**	**4 hours**	**SLO:2, 9**
Type of Photogrammetry, Stereoscopic Instruments / views, Vertical Photography, Ortho-photos, Oblique Photographs, Topographic Mapping , Digital Elevations/ Terrain Modelling			
Module: 7	**Applications of remote sensing and GIS**	**3 hours**	**SLO: 2**
Application of remote sensing and GIS in Civil Engineering, Case studies			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, New Delhi, Second Edition, (2012)

Reference Books

1. Thomos Lillesand, Ralph W. Kiefer and Jonathan Chripman, Remote Sensing and Image Interpretation, Wiley Publisher, 7th Edition, (2015).
2. Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd, Oxford University Press, 3rd Edition, (2015).
3. Kang-tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill Education; 8th Edition, (2015).
4. G S Srivastava, An Introduction to Geoinformatics, McGraw Hill Education (India) Private Limited, (2014)

5.	Paul Wolf, Bon DeWitt and Benjamin Wilkinson, Elements of Photogrammetry with Application in GIS, McGraw-Hill Education; 4th Edition, (2014)		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory Exercises	L Hr	SLO
1. Image Registration (Image to Image, Image to Map). 2. Image Subset / Clipping. 3. Spectral Signature of various land features. 4. Image Classification from satellite data sets. 5. Landuse and landcover Analysis. 6. Importing scanned and image file to GIS platform. 7. Digitization, attribute assigning, Raster to Vector formats. 8. Creating Thematic Layers/ Maps. 9. Spatial Analysis (Overlay, Buffering etc.). 10. DEM/DTM generation. 11. Extraction of Topographic parameters (slope, aspects, drainage etc.,) includes map creation. 12. Open Source data access.	30	14

Course Code	ADVANCED STRUCTURAL ANALYSIS	L	T	P	J	C
CLE3004		2	2	2	0	4
Pre-requisite	**CLE2003 Structural Analysis**	**Syllabus version**				
		1.2				

Course Objectives:

1. To understand the concept of gravity load
2. To learn the concepts of elastic analysis and plastic analysis
3. To understand the concepts of matrix analysis of structures.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know the importance of the shape factor and its importance
2. Distinguish determinate and indeterminate structures
3. Perform matrix methods of analysis

Student Learning Outcomes (SLO):	1, 9, 14

Module: 1	**Approximate methods for gravity loads**	**3 hours**	**SLO: 1, 9, 14**
Substitute frame method for dead load and live loads			
Module: 2	**Approximate methods for lateral loads**	**3 hours**	**SLO: 1, 9, 14**
Calculation of wind load, portal method - cantilever method - Factor method.			
Module: 3	**Plastic Analysis**	**4 hours**	**SLO:1, 9, 14**
Shape factor - simple sections - rectangular - triangle - circular - flanged sections - Load factor. Plastic moment of resistance - collapse load - analysis of continuous beams and portals - limiting conditions for applications.			
Module: 4	**Flexibility Method**	**5 hours**	**SLO:1, 9, 14**
Flexibility - compatibility equation - flexibility influence coefficients - force transformation matrix - flexibility matrix-analysis of beams & frames (rigid and pin-jointed).			
Module: 5	**Stiffness Method**	**5 hours**	**SLO:1, 9, 14**
Direct stiffness method - equivalent joint load - transformation matrix - development of structure stiffness matrix for axial element - assembly of structure stiffness matrix from element stiffness matrix - incorporation of boundary conditions.			
Module: 6	**Special Issues in Analysis of Structures**	**4 hours**	**SLO:1, 9, 14**
Thermal and initial strain (temperature change and misfit) - Displacement boundary conditions.			
Module: 7	**Introduction to Finite Element Method**	**4 hours**	**SLO: 1, 9, 14**
Introduction to basics of Finite Element modelling.			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1. Aslam Kassimali, Matrix Analysis of Structures, 2nd Edition, CENGAGE Learning Custom Publishing, 2011.
2. C.S. Reddy, Basic Structural Analysis, 3rd Edition, Tata Mcgraw Hill Education, 2014

Reference Books

1. Igor A. Karnovsky and Olga Lebed, Advanced methods of Structural Analysis, Springer New York. 2010
2. C. Natarajan and P. Revathi, Matrix methods of Structural Analysis: Theory and Problems, PHI Pvt Ltd, India, 2014
3. Pandit, G.S, & Gupta S.P, Structural Analysis (A matrix approach), Tata McGraw Hill Publishing Ltd., 2008.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory	L Hrs	SLO
1. Analyse a pin jointed static determinate truss	30	14
2. Analyse a pin jointed static indeterminate truss		
3. Analyse a continuous beam with different types of loading		
4. Analyse a portal frame with different type of loading		
5. Verification of portal method assumption and analysis for different bays		
6. Verification of cantilever method assumption and analysis for different bays		
7. Analysis of a 3 D truss		
8. Analysis of a 3D frame		
9. Modeling of a simple plan of a structure		

Course Code	GROUND WATER ENGINEERING	L	T	P	J	C
CLE3005		3	0	0	0	3
Pre-requisite	**CLE2004 Water Resources Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To educate on ground water movement analysis & predictions
2. To understand the concept to increase ground water potential
3. To identify the sources of the ground water

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Identify the ground water flow & prediction
2. Implement the Methods of improving the ground water potential
3. Manage the ground water sources

Student Learning Outcomes (SLO): 1, 2, 9

Module: 1	**Occurrence and Movement of Groundwater**	**6 hours**	**SLO: 1, 2**
Introduction to Hydrologic cycle – Origin and Age of groundwater- Vertical distribution of groundwater.			
Module: 2	**Types of Aquifer and groundwater movement**	**5 hours**	**SLO: 1, 2, 9**
Aquifer - water table - Darcy's Law, Coefficient of Transmissibility and storage – Determination of hydraulic conductivity-groundwater flow rates.			
Module: 3	**Well Hydraulics**	**6 hours**	**SLO: 1, 2, 9**
Steady Unidirectional flow -Study of steady radial flow – Unsteady radial flow in a confined and Unconfined aquifer –Multiple well system.			
Module: 4	**Water Well**	**4 hours**	**SLO: 1, 2, 9**
Characteristic well losses, open well, tube well, well depth, well screen – Slug tests			
Module: 5	**Analysis and Evaluation of Pumping Test**	**7 hours**	**SLO: 1, 2,9**
Definition of terms - static water level, pumping level, drawdown – residual, drawdown pumping rate - automatic water level recorder - time drawdown analysis - distance drawdown analysis, Jacob's methods, pumping test methods.			
Module: 6	**Pollution of Groundwater**	**7 hours**	**SLO: 1, 2**
Measures of water quality- chemical analysis - graphical representation-physical analysis- biological analysis - Pollution in relation to water use - sources, municipal, industrial, agricultural, evaluation of pollution potential. Remedial measures for ground water contamination.			
Module: 7	**Management of Groundwater and Groundwater Flow Modelling Techniques**	**8 hours**	**SLO: 1, 2, 9**
Concepts of Basin Management-Groundwater basin Investigations and data collection-Yield-Conjunctive use and Watershed management- Water laws and policies Types of groundwater models- simulation of two and three dimensional groundwater system-MODFLOW 2000			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**45 hours**	

Text Book(s)

1. David K Todd and Larry W. Mays (2013), Groundwater Hydrology, Third Edition, John Wiley & Sons Singapore.

Reference Books			
1.	Rastogi R K, Applied groundwater hydrology, (2011).		
2.	Raghunath H.M., Groundwater, Second Edition, Wiley Eastern Limited, New Delhi, (2012).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	TRAFFIC ENGINEERING	L	T	P	J	C
CLE3007		2	0	0	4	3
Pre-requisite	**CLE2005 Transportation Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To study the concepts of traffic engineering
2. To understand the methods for efficient management of traffic in urban roads

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Perform traffic data collection, analysis and interpretation
2. Know importance of traffic management
3. Perform the accident studies

Student Learning Outcomes (SLO):	2, 9, 14

Module: 1	**Basic Concept of Traffic Characteristics**	**4 hours**	**SLO: 2, 9**

Parameters used to describe a traffic stream – Macroscopic and microscopic level - Flow, Speed, Density – Time headway, Time mean speed, Space headway - Their basic relationship – Fundamental traffic flow equation

Module: 2	**Traffic Stream Models**	**4 hours**	**SLO: 9, 14**

Introduction to traffic stream models – Greenshield's, Greenberg, Underwood, Northwestern models – Application of traffic stream models – Shock waves

Module: 3	**Traffic Studies**	**5 hours**	**SLO: 2, 9, 14**

Traffic studies – Volume, speed, density, time headway, space headway, travel time and parking – Methods of data collection – Statistical analysis – Application of Poisson model – Gap acceptance studies – Queueing models

Module: 4	**Highway capacity and Level of service**	**4 hours**	**SLO: 2, 9**

Basic definitions related to capacity – Level of service (LOS) concept – Factors affecting capacity and LOS – Computation of capacity and LOS for 2-lane highways – Multilane highways – Freeways – IRC guidelines

Module: 5	**Traffic Signals**	**4 hours**	**SLO: 9, 14**

Traffic signals – Warrants for signalization – Design of traffic signal by Webster method – Signal coordination and area traffic control – IRC guidelines

Module: 6	**Traffic Regulations and Management**	**4 hours**	**SLO: 2**

Introduction to Transportation System Management (TSM) - Measures for improving vehicular flow – one way streets, transit stop relocation, parking management, reversible lanes - Reducing Peak Period Traffic - Strategies for working hours - Congestion Pricing - Traffic signs and roadway markings - Types, specification

Module: 7	**Roadway Safety**	**3 hours**	**SLO: 2, 14**

Purpose of accident studies - Accident data collection – Identification of accident hot spots - Use of Global Positioning Systems (GPS) and Geographic Information Systems (GIS) – Causative factors of road accidents - Predictive models - Road Safety Auditing - Measures to increase Road safety.

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1.	Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski (2012) "Principles of Highway Engineering and Traffic Analysis", John Wiley & Sons.		
Reference Books			
1.	Nicholas Garber, Lester A. Hoel, "Traffic and Highway Engineering", 5th Edition, Cengage Learning, USA, (2015).		
2.	L.R.Kadiyali, N.B.Lal, "Traffic Engineering and Transport Planning", Khanna Publishers, New Delhi, India, (2011).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Project Titles (J component) **60 hrs**

Challenging projects for Individual or a group will be given based on the basic and advancements in the course content

Course Code	TRANSPORT PLANNING AND MANAGEMENT	L	T	P	J	C
CLE3008		2	0	0	4	3
Pre-requisite	**CLE2005 Transportation Engineering**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the concepts of travel demand modeling
2. To predict the future travel demand
3. To evaluate transport planning alternates

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Study the trip generation, distribution, modal split and assignment of traffic
2. Economic evaluation of transportation planning alternates

Student Learning Outcomes (SLO):	1, 9, 14

Module: 1	**Transport Planning Process**	**6 hours**	**SLO: 1, 9**

Scope – Urban transportation systems - Systems approach to transportation planning – Long term vs Short term – Simultaneous vs sequential approaches – Aggregate vs disaggregate approaches.

Module: 2	**Transportation Planning Surveys**	**3 hours**	**SLO: 14**

Transport survey – definition of study area and traffic zones – External cordon line – Sample size – Home interview survey and cordon line surveys - inventory of existing transport facilities, land use and economic activities.

Module: 3	**Trip Generation**	**4 hours**	**SLO:1, 9, 14**

Factors governing trip generation: physical, social and economic – multiple regression analysis – category analysis

Module: 4	**Trip Distribution**	**4 hours**	**SLO:1, 9**

Presentation of Trip distribution data – PA matrix to OD matrix - Growth factor methods - Gravity model and its calibration – opportunities model.

Module: 5	**Modal Split Analysis**	**4 hours**	**SLO:9,14**

Factors influencing mode choice – Modal split models – Trip end and trip interchange – Disaggregate mode choice models - Discrete choice models

Module: 6	**Traffic assignment**	**4 hours**	**SLO:1, 9**

Traffic assignment – general principles – description of highway network – Moore's shortest path algorithm - assignment techniques – all nothing assignment – capacity restrained assignment – diversion curves

Module: 7	**Transport Economics**	**3 hours**	**SLO: 1, 9, 14**

Economic evaluation techniques – Benefit cost ratio, NPV method, IRR method – Comparison – Examples

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	L.R. Kadiyali, Traffic Engineering and Transport planning, Khanna Publishers, New Delhi, (2011).

Reference Books

1.	Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons, (2012).
2.	Papacostas and Prevedouros, Transportation Engineering and Planning, Pearson, India, (2015).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	ARCHITECTURE AND TOWN PLANNING	L	T	P	J	C
CLE3010		2	0	0	4	3
Pre-requisite	**CLE2001 Building Drawing**	**Syllabus version**				
		1.0				

Course Objectives:

1. To learn the Architectural aspects and to understand the history of Romans, Greek, and South Indian Architecture.
2. To know the different type of architectures and its importance
3. To understand the basic principles of town planning

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Know the Architecture that can enhance the building in terms of appearance and utility
2. Provide solutions to the problem that are coming in Town Planning
3. Know the different qualities of architecture

Student Learning Outcomes (SLO): 2, 5, 10, 15

Module: 1	**Basics of Architecture**	**6 hours**	**SLO: 2**

Principles of architectural composition – unity, balance, proportion, scale, contrast, harmony, accentuation, restraint, definition, repose, vitality, strength - with the help of illustrations of buildings, Organizing principles of architectural composition – symmetry, hierarchy, datum, axis, rhythm – different types of spatial organizations of masses – linear, centralized, radial, clustered, grid organization – illustrations of buildings.
Use of different materials - Styles in architecture - Anthropometrics , furniture layout - circulation - lighting and ventilation for spaces

Module: 2	**Skills for an Architectural Understanding**	**3 hours**	**SLO: 2**

Various Drawing Skills - Visualization Skills - Model Making skills - Thinking & Analytical Skills - Empathy - Philosophical Understanding from Idea to Form - Psychological and Social Understanding

Module: 3	**Architecture in Timeline**	**5 hours**	**SLO:2, 5**

Understanding the construction methods and materials through study of Egyptian, Greek, Roman, European, Indian Architectural History - Modern Architecture - Contemporary Architectural Practice

Module: 4	**Interior Design**	**3 hours**	**SLO: 2, 5**

Interior Planning and treatment – Use of natural and synthetic building materials – Thermal and Accoustical materials – Furniture and Fittings.

Module: 5	**Human Settlements**	**3 hours**	**SLO:5, 15**

Planned and organic - typologies of cities like Capital, Port, Rural etc- Elements of human settlements

Module: 6	**Town Planning Principles**	**4 hours**	**SLO:5, 10, 15**

Planning ideologies – Importance of Climate topography, drainage and water supply in the selection of site for the development – Residential – Commercial – Industrial – Public – Transportation, Utility and services – Agriculture.

Module: 7	**Smart Cities - Opportunities And Challenges**	**4 hours**	**SLO: 5, 10, 15**

Indian scenario - need for smart cities - Issues and Opportunities. Green Building.

Module: 8	**Contemporary issues**	**2 hours**	**SLO: 5, 10**
	Total Lecture hours	**30 hours**	

Text Book(s)

1. De Charia & Callender, Architecture, Mc. Graw Hill, (2012).

Reference Books

1. Gallion, Urban pattern City planning and design, Charotar Publishing House, (2010).

2.	Modak & Ambedkar, Town and Country Planning and Housing, (2001).		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Sample projects - J component (60 hours of work by a group of students)	
1. Design of a Restaurant / any other medium sized project that calls for both interior and exterior design. 2. Intervene with Architecture / Town planning solution to a localised social or urban Issue. 3. Green Ideation projects 4. Architectural projects that carry more structural design emphasis. 5. Smart City (intervention) solutions Projects	60 hrs

Course Code	FINITE ELEMENT METHODS	L	T	P	J	C
CLE3011		2	2	0	0	3
Pre-requisite	**CLE2003 Structural Analysis**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the concepts of finite element methods
2. To learn one dimensional and two dimensional analysis

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the principles of elasticity
2. Perform one dimensional and two dimensional analysis
3. Analyse flexibility and stiffness matrix

Student Learning Outcomes (SLO):	1, 2, 9

Module: 1	**Introduction**	**4 hours**	**SLO: 1, 2, 9**

Concepts of finite element methods - Steps involved - merits and demerits - Energy principles - Discretization.

Module: 2	**Principles of Elasticity**	**4 hours**	**SLO: 1, 2, 9**

Equations of equilibrium - Stress equations - Stress - strain relationship - Strain - displacement matrix - Plane stress and plane strain conditions.

Module: 3	**Theory of Finite Element methods**	**4 hours**	**SLO:1, 2, 9**

Concept of an element - Various element shapes - Displacement models - Approximation displacements by polynomials - Convergence requirements - Shape functions.

Module: 4	**One dimensional FEM**	**4 hours**	**SLO:1, 2, 9**

Stiffness matrix for bar and beam element - one dimensional problems.

Module: 5	**Two dimensional FEM**	**4 hours**	**SLO:1, 2, 9**

Minimization of band width - Analysis of two dimensional framed structures (trusses, frames) for loads and displacements.

Module: 6	**Natural coordinate system**	**4 hours**	**SLO:1, 2, 9**

Area and volume coordinates - Lagranges's and serendipity elements - Numerical integration techniques.

Module: 7	**Isoparametric formulation**	**4 hours**	**SLO: 1, 2, 9**

Concepts of isoparametric formulation - Iso parametric Bar element - Plane bilinear isoparametric element.

Module: 8	**Contemporary issues**	**2 hours**	
	Total Lecture hours	**30 hours**	

Text Book(s)

1.	Krishnamoorthy, C.S, "Finite Element Analysis", Tata McGraw Hill Publishing Co. Ltd., 2015

Reference Books

1.	Tirupathi R. Chandrupatla and Ashok D. Belugundu, Introduction to Finite Elements in Engineering, Prentice Hall, (2011).
2.	Mukhopadhyay, M., & Sheikh, A. H., Matrix and finite element analyses of structures, Ane Books, (2011).
3.	Larson, M. G., Finite element method: theory, implementation, and applications, Springer, (2013).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	DESIGN OF STEEL STRUCTURES	L	T	P	J	C
CLE4001		3	0	2	0	4
Pre-requisite	**CLE3002 Basics of Structural Design**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the concepts of steel design
2. To know the analysis and design of plate girder and gantry girder and its applications
3. To identify the different types of roofs and roofing system

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Design a simple beam and built up beam
2. Design plate girders
3. Design roof trusses
4. Design overhead water tanks.

Student Learning Outcomes (SLO):	1, 6, 14

Module: 1	**Braced and Moment Frames**	**6 hours**	**SLO: 1, 6**
Design of braced frames – moment frames.			
Module: 2	**Design of industrial structures**	**6 hours**	**SLO: 1, 6, 14**
Roof Trusses - calculation of dead load- live load & wind load - Design of joints - supports - members for pitched roof truss - purlins.			
Module: 3	**Water Tanks**	**7 hours**	**SLO:1, 6, 14**
Overhead water tanks - pressed steel tanks - design of staging and foundation.			
Module: 4	**Light Gauge Sections**	**6 hours**	**SLO: 1, 6, 14**
Design of light gauge steel members - local and post buckling of thin element - light gauge steel compression members - tension members - beams and connections.			
Module: 5	**Design of Steel Gable Frame and Beam Columns**	**6 hours**	**SLO: 1, 6, 14**
Design of steel gable frame - beam column - base plate and anchor bolt.			
Module: 6	**Design of Steel, concrete composite structures**	**6 hours**	**SLO: 1, 6, 14**
Dimensions of steel stacks - loading and load combinations. Slabs, Beams, Columns			
Module: 7	**Detailing of Steel Structures**	**6 hours**	**SLO: 1,6**
Detailing and drawing of frames - water tanks - gable frames			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**45 hours**	

Text Book(s)

1. Subramanian, N," Design of Steel structures", Oxford University press, New Delhi, 2011.

Reference Books

1. Ramchandra .S., Virendra Ghelot, “Design of Steel of Structures”, Volume 1, Scientific Publishers, New Delhi, 2011
2. Duggal .S.K. “Limit State Design of Steel Structures”, Tata McGraw Hill Publishing Company, New Delhi, 1st Edition, 2010.
3. BhavikattiS.S."Design of Steel Structures by Limit State Method as Per IS: 800 - 2007", I.K.International Pvt Ltd, 2009.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Laboratory Exercises	Hrs	SLO
Design and drawing of • Water tanks • Steel roof trusses • Gable frames	30	14

Course Code	DESIGN OF ADVANCED CONCRETE STRUCTURES	L	T	P	J	C
CLE4002		2	0	0	4	3
Pre-requisite	**CLE3002 Basics of Structural Design**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the design of columns
2. To understand the design of bridges
3. To know the importance of the retaining wall and its applications

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Design columns
2. Design Bridges
3. Implement the analysis and design of retaining walls

Student Learning Outcomes (SLO):	1, 2, 6

Module: 1	**Yield line theory of slab design**	**3 hours**	**SLO: 1, 2**
Yield line theory - Assumptions made in analysis - Hillerborg's Theory - Analysis of isotrophic conditions - virtual work method and equilibrium method.			
Module: 2	**Design of Structural frames**	**3 hours**	**SLO: 1, 2, 6**
Design of Stair Case - Design of slender columns - uni-axial and biaxial bending			
Module: 3	**Introduction to Frame analysis**	**4 hours**	**SLO: 1, 2**
Substitute frame method - cantilever method and portal frame method.			
Module: 4	**Retaining Walls**	**5 hours**	**SLO: 1, 2**
Design of walls - cantilever and counter fort retaining walls.			
Module: 5	**Water Tanks**	**5 hours**	**SLO: 1, 2**
Design of under - ground rectangular tanks - circular tank -Design of over-head rectangular tanks - circular tank – domes.			
Module: 6	**Design of Bridges**	**5 hours**	**SLO: 1, 2, 6**
Classification of bridges - IRC code - Pigeaud's method - Coulomb's method - design of slab bridge			
Module: 7	**Design of Deep beams**	**3 hours**	**SLO: 1, 2, 6**
Design of simply supported and continuous deep beams.			
Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)

1.	Bhavikatti S, (2016), Advanced RCC Design (Volume 1 and Volume 2), New Age International.

Reference Books

1.	Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice-Hall of India, New Delhi, 2011.
2.	Ramamrutham S, Design of Reinforced Concrete Structures, Dhanpat Rai Publishers, 2016
3.	Gambhir.M. L. "Design of Reinforced Concrete Structures", Prentice Hall of India, 2012.
4.	Unni krishna Pillai and Devdas Menon "Reinforced Concrete Design', Third Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2017.
5.	IS 456 : 2000 Plain and Reinforced Concrete - Code of Practice

6.	IS 13920 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces -Code of Practice		
7.	IS 3370 Water Retaining Structures		
8.	IRC Specifications		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Samples projects for J component

S. No.	Project Titles	Hrs
1.	Study influences of the yield line theory and practicality study on the slabs	60
2.	Functional requirements of staircases and design of stair case	
3.	Identifying the parameters influencing and design limitations in the long columns	
4.	Flawless design and detailing of RCC structural components	
5.	Design of a retaining wall for a minor bridge	
6.	Design of a high-steep reinforced soil retaining wall	
7.	Design and analysis of rectangular water tank resting on ground	
8.	Seismic Behavior & Design of RC Shear Walls	
9.	Influence of orientation of shear walls on structural behavior of RC buildings	
10.	Design of flat slab for a commercial building	
11.	Comparison of structural behavior of conventional roof and flat slab system	
12.	Design of a deep beam for an aesthetic building	
13.	Design of a arch bridge	
14.	Design of a railway bridge	

Course Code	PRESTRESSED CONCRETE DESIGN	L	T	P	J	C
CLE4003		3	0	0	0	3
Pre-requisite	**CLE3002 Basics of Structural Design**	**Syllabus version**				
		1.0				

Course Objectives:

1. To understand the concepts of pre-stressing
2. To learn the creep and shrinkage of concrete
3. To design and analyse the flexural member

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Design the pre-tensioning and post-tensioning members
2. Design the flexural member.

Student Learning Outcomes (SLO): 2, 5, 6

Module: 1	**Introduction**	**6 hours**	**SLO: 2, 5**

Concept of Prestressing - Types of Prestressing - Advantages - Limitations -Prestressing systems - Anchoring devices - Materials - Mechanical Properties of high strength concrete - high strength steel - Stress-Strain curve for High strength concrete.

Module: 2	**Analysis of members**	**6 hours**	**SLO: 2, 5, 6**

Analysis of members at transfer - Stress concept - Comparison of behavior of reinforced concrete - prestressed concrete - Force concept - Load balancing concept - Kern point - Pressure line.

Module: 3	**Losses in Prestress**	**6 hours**	**SLO:2, 5, 6**

Loss of Prestress due to Elastic shortening, Friction, Anchorage slip, Creep of concrete, Shrinkage of concrete and Relaxation of steel - Total Loss.

Module: 4	**Deflection and Crack Width**	**6 hours**	**SLO: 2, 5, 6**

Calculations of Deflection due to gravity loads - Deflection due to prestressing force - Total deflection - Limits of deflection - Limits of span-to-effective depth ratio - Calculation of Crack Width - Limits of crack width.

Module: 5	**Design of Sections for Flexure**	**6 hours**	**SLO: 2,5, 6**

Analysis of members at ultimate strength - Preliminary Design - Final Design for Type 1 members - Magnel's graphical method

Module: 6	**Design for Shear**	**6 hours**	**SLO: 2, 5, 6**

Analysis for shear - Components of shear resistance - Modes of Failure - Limit State of collapse for shear - Design of transverse reinforcement.

Module: 7	**Composite sections**	**6 hours**	**SLO: 2,5, 6**

Types of composite construction - Analysis of composite sections - Deflection -Flexural and shear strength of composite sections.

Module: 8	**Contemporary issues**	**3 hours**	
	Total Lecture hours	**45 hours**	

Text Book(s)

1.	Krishna Raju. N., Pre-stressed Concrete - Problems and Solutions, CBS Publishers and Distributors, Pvt. Ltd., New Delhi, 2014.

Reference Books

1.	Praveen Nagarajan, Advanced Concrete Design, Person, 2013
2.	P. Dayaratnam, Prestressed Concrete Structures, Oxford & IBH-Pubs Company, Delhi, 5th Edition, 2009
3.	IS: 1343: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
4.	IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th ACM	Date	18.03.2016

Course Code	SEISMIC DESIGN OF STRUCTURES	L	T	P	J	C
CLE4004		2	2	0	0	3
Pre-requisite	**CLE3002 Basic Structural Design**	**Syllabus version**				
		1.1				

Course Objectives:

1. To understand the fundamental concepts in the analysis of the structures subjected to seismic forces.
2. To do a competent design & detailing of seismic resistant structures.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Understand the concepts of theory of vibrations, free vibrations of different degree of freedom and dynamic response to time dependent forces.
2. Learn about the computation of design moments and shears for framed structure as per IS:1893 and its detailing
3. Understand the estimation of member forces in single-storied R.C.C., design and detailing of members.
4. Learn about the application of response spectrum theory to seismic design of structures.
5. Understand the concepts of earthquake resistance design and code provisions for design of building as per IS 1893 and IS 13920.

Student Learning Outcomes (SLO): 2, 5, 6

Module: 1	**Seismology and earthquake**	**4 hours**	**SLO: 2, 5**

Internal structure of the earth - discontinuity and nature of the material - continental drift and plate tectonics - Faults - Elastic rebound theory - seismic waves and characteristics - earthquake size - seismic zoning map of India.

Module: 2	**Dynamics of structures**	**3 hours**	**SLO: 2, 5, 6**

Theory of vibrations - free and forced vibrations - single and multi-degree of freedom systems - computations of dynamic response to time dependent forces.

Module: 3	**Principles of earthquake resistant design**	**5 hours**	**SLO:2, 5, 6**

Importance of Earthquake Resistant Design - Seismic Forces - modes of propagation - Factors influencing seismic vulnerability - Characteristics of earthquake - Earthquake response of structures - Application of response spectrum theory in seismic design - Concept of earthquake resistance design - Codal provisions for seismic design of structures – IS 1893 and IS 4326.

Module: 4	**Seismic analysis of moment resisting frames**	**4 hours**	**SLO:2, 5, 6**

Seismic design philosophy, determination of design lateral forces as per IS: 1893 - equivalent static force and dynamic analysis procedure - Effect of infill stiffness on analysis of frames - equivalent diagonal strut.

Module: 5	**Design of beam column junctions**	**3 hours**	**SLO:2, 5, 6**

Elastic and Inelastic deformations of structures - ductility of the composite system - design of axial and flexural members - beam column junction detailing - strong column weak beam effects as per IS: 13920.

Module: 6	**Design of shear walls**	**4 hours**	**SLO:2, 5, 6**

Unreinforced and reinforced masonry shear walls - analysis and design of reinforced concrete shear walls - Bearings - Friction dampers - Tuned mass dampers.

Module: 7	**Design of structures**	**5 hours**	**SLO: 2, 5, 6**

Seismic design of RC structures using - static and dynamic methods - equivalent static, response spectrum and time history methods.

Module: 8	**Contemporary issues**	**2 hours**	
Total Lecture hours		**30 hours**	

Text Book(s)			
1.	Pankaj Agarwal and Manish Shrikhande, Earthquake resistant design of structures, Prentice-Hall India Pvt Ltd., 2012		
2.	Duggal, S.K, "Earthquake Resistant Design of Structures", Oxford university press, 2007.		
Reference Books			
1.	Park, R &Paulay, "Design of Reinforced Concrete Structure Elements", John Wiley & sons, 2009.		
2.	Kramer.S.L, "Geotechnical Earthquake Engineering", Prentice-Hall India Pvt. Ltd., 2010.		
3.	IS: 1893 (Part 1)-2002, Criteria for earthquake resistant design of structures, BIS, New Delhi.		
4.	IS: 13920-1993, Ductile detailing of reinforced concrete structures subjected to seismic forces, BIS, New Delhi.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40^{th} ACM	Date	18.03.2016

Course Code	OPERATIONS RESEARCH	L	T	P	J	C
MEE1024		2	2	0	0	3
Pre-requisite	MAT2001 Statistics for Engineers	Syllabus version				
Anti-requisite	Nil	v. xx.xx				

Course Objectives:

- To provide students the knowledge of optimization techniques and approaches.
- To enable the students apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
- To teach students about networking, inventory, queuing, decision and replacement models.

Expected Course Outcome:

Student will be able to

- Illustrate the use of OR tools in a wide range of applications in industries.
- Analyze various OR models like Inventory, Queuing, Replacement, Simulation, Decision etc and apply them for optimization.
- Gain knowledge on current topics and advanced techniques of Operations Research for industrial solutions.

Student Learning Outcomes (SLO): **1,7,17**

Module:1	Linear Programming Problem	4 hours	SLO: 1,7

Introduction to Operations Research – Linear Programming - Mathematical Formulation – Graphical method – Simplex method – Penalty methods: M-method, Two Phase method- Duality.

Module: 2	Transportation Problem	4 hours	SLO: 1,7

Introduction - Formulation - Solution of the transportation problem (Min and Max): Northwest Corner rule, row minima method, column minima method, Least cost method, Vogel's approximation method – Optimality test: MODI method.

Module: 3	Assignment and Sequencing Models:	3 hours	SLO: 1,17

Assignment problems – Applications - Minimization and Maximization; Sequencing - Problem with N jobs and 2 machines – n jobs and 3 machines problem - n jobs and m machines problem.

Module: 4	Project Management	4 hours	SLO: 1,7

Introduction - Phases of project management-Construction of Network diagrams- Critical path method (CPM) and Project evaluation and review technique (PERT) - Crashing of project network.

Module: 5	Inventory Control	4 hours	SLO: 1,17

Necessity for maintaining inventory - Inventory costs -Inventory models with deterministic demand - inventory models with probabilistic demand - Inventory models with price breaks - Buffer stock.

Module: 6	Queuing Models	4 hours	SLO: 1,17

Poisson arrivals and Exponential service times – Single channel models and Multi-channel models - Simulation: Basic concepts, Advantages and disadvantages - Random number generation - Monte Carlo Simulation applied to queuing problems.

Module: 7	Game theory and Replacement Models	5 hours	SL O: 1,17

Game theory: Competitive games - Useful terminology - Rules for game theory - Two person zero sum game – Property of dominance - Graphic solution – Algebraic method.

Replacement models: Replacement of items that deteriorate with time: No changes in the value of money, changes in the value of money - Items that fail completely: Individual replacement and group replacement policies.

Module: 8	Contemporary issues	2 hours	
	Total Lecture hours	30 hours	

Tutorial

- A minimum of 3 problems to be worked out by students in every tutorial class.
- 5 problems to be given as homework per tutorial class.

SLO: 1,7,17

• At least one open ended design problem to be given.	
Tutorial Class for Module 1 Tutorial Class for Module 2 Tutorial Class for Module 3 Tutorial Class for Module 4 Tutorial Class for Module 5 Tutorial Class for Module 6 Tutorial Class for Module 7 # A minimum of 3 problems to be worked out by students in every tutorial class. Another 5 problems per tutorial class to be given as home work. # Mode: Individual exercises, Team exercises.	**30 hours**

Text Book(s)	
1.	Hamdy A Taha, Operations Research: An Introduction, 9th edition, Pearson Education, Inc., (2014)
Reference Books	
1.	Hira D S and Gupta P K, Operations Research, Revised edition, S. Chand & Sons, (2014)
2.	Kanti Swarup, Gupta P.K., and Man Mohan, Operations Research, 18th edition, S. Chand & Sons, (2015).
3.	Manohar Mahajan, Operations Research, Dhanpat Rai & Co., (2013).

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017