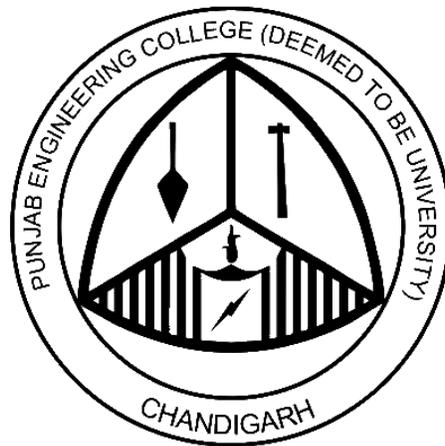


PG-Curriculum
(Structure and Course Contents)
Transportation Engineering
With effect from July 2018



Civil Engineering Department
Punjab Engineering College
(Deemed to be University)
Chandigarh

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PG Curriculum Structure

S. No.	Course Stream	Course Name	Credits	When it runs in a semester					
				1	2	3	4	5	6
Semester I									
1.	Soft Computing	Internet of Things	1.5						
		Machine Learning	1.5						
2.	Soft Skills and Management	Communication Skills (CS)	1.5						
		Management and Entrepreneurship(M)/IPR	1						
		Professional Ethics (PE)	0.5						
3.	Program Core-I	Advanced Traffic Engineering	3						
4.	Program Core-II	Pavement Analysis and Design	3						
5.	Program Elective-I: E1	<ul style="list-style-type: none"> • Geometric Design of Transportation Infrastructure • Advanced Soil Engineering • Land Use and Regional Transportation Planning • Airport Infrastructure, Planning and Design 	1.5						
	Program Elective-II: E2	<ul style="list-style-type: none"> • Pavement Management System • Intelligent Transportation Systems • Railway Infrastructure, Planning and Design • Remote Sensing and GIS 	1.5						
6.	Engineering Mathematics (EM)	Engineering Mathematics- I (Fourier Transform)	1						
		Engineering Mathematics- II (Numerical Methods)	1						
		Engineering Mathematics- III (Optimization techniques)	1						
Total Credits			18						

Sr. No.	Course Stream	Course Name	Credits	When it runs in a semester					
				1	2	3	4	5	6
Semester II									
1.	Design Of Experiments and Research Methodology	Design of Experiments and Research Methodology	3						
2.	Program Core III	1. Highway materials, Design and Construction	1.5						
		2. Management of Transport Infrastructure Projects	1.5						
3.	Program Core-IV	Transportation System Planning and Management	3						
4.	Program Elective-III: E3	<ul style="list-style-type: none"> • Transportation Economics and Finance • Ground Improvement Techniques • Advanced Foundation Engineering 	1.5						
	Program Elective-IV: E4	<ul style="list-style-type: none"> • Docks and Harbour Engineering • Road Safety Engineering • Bridge Engineering 	1.5						
5.	Open Elective	Transportation and Environment	1.5						
		Road Safety Engineering	1.5						
6.	Mini project/ Pre-dissertation		3						
Total Credits			18						

Summer Term *

S. no.	Course Code	Course Name	Credits
1		Industrial Visit (3 days to 1 week of visit, Submission and presentation of visit report)	Satisfactory/ Non-satisfactory

*After Examination of second semester, in the first week of summer vacation industry visit can be undertaken.

Course No.	Course Name	Credits	When it runs in a semester					
			1	2	3	4	5	6
Semester-III								
1.	Dissertation/Industry Project	14						

Course No.	Course Name	Credits	When it runs in a semester					
			1	2	3	4	5	6
Semester-IV								
1.	Dissertation/Industry Project	18						

Total credits – 68

- *20% courses/ semester can be offered in blended mode MOOC's/Industry.*
- *MOOC's/Industry offered course is having fractional credits. Industry offering course content will be designed by industry will be as per expert availability. Industry person will deliver and evaluate this subject. As per the duration of MOOC's/industry offered course, credits of this course can be decided (fractional credits).*

Semester-I

Soft Computing

Course Name	:	Internet of Things
Course Code	:	SCM 5011
Credits	:	1.5
L T P	:	2-0-2
Segments	:	1-3

Total No. Lectures:-14
Total No. of Lab hours – 14

Course Objectives:

1.	To be able to understand IoT architecture and market perspective
2.	To enhance the understanding of the basic principles and operation of different types of sensors commonly used on mobile platforms

Course Contents:

S. No.	Course Contents	No. of Lectures
1.	Introduction to IOT What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market , Privacy issues in IOT	2
2.	Setting Up Raspberry Pi/Arduino to Create Solutions Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS.	3
3.	Communication Protocols used in IoT Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, WIFI, ZigBee, 6LoWPAN), Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT, LPWAN)	3
4.	IoT Applications IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Smart Grids , Brownfield IoT, Smart Objects, Smart Applications	3
5.	Sensors Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer,	3

	Magnetometer, Proximity Sensor, Gyroscope, Calibration, - noise Modeling and characterization, and - noise filtering and sensor data processing, Privacy & Security, Selection of Sensors for Practical Applications	
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Lab Work:

S. No.	Lab contents	No. of Hours
1.	Setting up Raspberry Pi and Arduino	2
2.	Build small scale wireless communicating IOT device	4
3.	Integrate positioning sensors to IOT device	4
4.	Integrate motion and orientation sensors to IOT device	4

Course Outcomes:

At the end of the course, students will have:	
1	Understand the concept of IOT
2	Study IOT architecture and applications in various fields
3	Study the security and privacy issues in IOT.
4	Understand various applications of sensor in Industrial, healthcare, commercial, and building automation.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1.	Vijay Madiseti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", VPT, 1st Edition	2014
2.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition	2013
3.	CunoPfister, "Getting Started with the Internet of Things", O-Reilly Media	2011
4.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing	2015

Course Name	:	Machine Learning
Course Code	:	SCM 5012
Credits	:	1.5
L T P	:	2-0-2
Segments	:	4-6

Total No. Lectures:-14
Total No. of Lab hours – 14

Course Objectives:

1. The students should be able to design and implement machine learning solutions to classification, regression and clustering problems; and be able to evaluate and interpret the results of the algorithms
--

Course Contents:

S.No.	Course Contents	No. of Lectures
1.	Python Introduction, Conditional Statements, Looping, Control Statements, String Manipulation, Lists, , Tuple, Dictionaries, Functions, Modules, Input-Output, Exception Handling	4
2.	Supervised Learning Linear Regression, Support Vector Machines, Decision Tree Learning	3
3.	Unsupervised Learning K-means, hierarchical clustering, principal component analysis, Neural Networks	4
4.	Reinforcement and Control Learning Introduction to reinforcement and control learning, Algorithms of control learning	3

Lab Work:

S. No.	Lab contents	No. of Hours
1.	A small scale gaming application	8
2.	Learn how to automate day-to-day tasks using Python.	6

Course Outcomes:

At the end of the course, students will have:	
1	Understand advantages and disadvantages of different machine learning algorithms
2	Identify suitability of machine learning algorithms for different domains

Bibliography:

S.No.	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1.	TanejaSheetal, Kumar Naveen, “Python Programming: A modular approach by Pearson”, Pearson Education; First edition	2016
2.	Paul Barry, “Head First Python: A Brain-Friendly Guide”,	2016

	Shroff/O'Reilly; Second edition	
3.	Tom M. Mitchell, "Machine Learning", McGraw Hill Education; First edition	2017
4.	Yuxi (Hayden) Liu, "Python Machine Learning By Example", Packt Publishing Limited	2017

Soft Skills & Management

Course Name	:	Communication Skills (CS)
Course Code	:	SSM 5021
Credits	:	1.5
L T P	:	0-1-4
Segments	:	1-3

Total No. Tutorials:- 07

Total No. of Lab hrs:- 28

Course Objectives:

- | |
|--|
| <ol style="list-style-type: none"> 1. To enhance competence in communication skills: verbal and nonverbal. 2. To provide orientation in technical communication skills: spoken and written. 3. .To sensitize students to attitude formation and behavioural skills. |
|--|

Total No. Tutorials:- 07

S. No.	Course Contents	No. of Lectures
1.	Introduction to Communication Skills, Soft Skills and Interpersonal Communication	1
2.	Speech: Structure, Elements, Content, Organization and Delivery J-a-M	1
3.	Writing Skills: Letters, Minutes of Meeting	1
4.	Technical Report Writing: Concept & Structure	1
5.	Research Writing: Concept & Structural Framework	1
6.	Power Point Presentation: Project Presentation	1
7.	Interviews	1

Lab Work

S. No.	Lab. Contents	No. of Hours
1.	Self- Introduction	2
2.	Negotiation Skills & Role Play	2
3.	J-a-M Session	2
4.	Building Word Power through Reading	2
5.	Group Discussion and Case Study	4
6.	Writing Skills: Letters, Minutes of Meeting	2
7.	Technical Report Writing: Concept & Structure	4
8.	Research Writing: Concept & Structural Framework	4
9.	Power Point Presentation: Project Presentation	4
10.	Interviews	2

Course Outcomes

At the end of the course, students will be able to	
1	Enhance their competence in communication and technical communication and develop awareness of attitude formation and behavioural appropriateness.
2	The course will address the gap which exists between employer expectations and student proficiency.

Bibliography:

S. No.	Book Detail	Year of Publication
1.	Technical Communication, Meenakshi Raman and Sangeeta Sharma, Oxford University Press	2015
2.	English for Research Paper Writing, Adrian Wallwork, Springer, London	2011
3.	English Vocabulary In Use: Advanced+ CD, McCarthy Michael, CUP, Cambridge	2004
4.	Advanced English Grammar, Martin Hewings, CUP, Cambridge	2003
5.	Study Listening, Lynch Tony, CUP, Cambridge	2004
6.	Study Speaking , Anderson Kenneth, CUP, Cambridge	2010
7.	Study Reading , Glendenning H. Eric, CUP, Cambridge	2004
8.	Study Writing , Lyons Liz Hamp& Ben Heasley, CUP, Cambridge	2004
9.	Study skills in English, Michael J. Wallace, CUP, Cambridge	2004

Course Name	:	Management and Entrepreneurship/ IPR
Course Code	:	SSM 5022
Credits	:	1
L T P	:	0-3-0
Segments	:	4-5

Total No. Tutorials:- 14

Course Objectives:

- | |
|--|
| <p>1. The main aim of this course is to make students familiar with the concepts of Management and Entrepreneurship and understand how to develop new start-up and manage it effectively. It also aims to create awareness about the concepts of Innovation, Ideation and IPR.</p> |
|--|

Course Contents:

S. No.	Course Contents	No. of Tutorials
1.	Principles and Functions of Management	1
2.	Planning Process - Hypothetical Planning of an Event/Activity	1
3.	Form of Organization Structure - Case Study	1
4.	Human Resource Planning and Process, Current HR Practices	2
5.	Elements of Directing and Effective Control Mechanism Activity: Role Playing/Management Game	2
6.	Concepts of Entrepreneurship and Characteristics of Entrepreneurs	1
7.	Development Phases of Entrepreneurship -Idea Generation -Project Formulation and Validation -Business plan	4
8.	Ecosystem for Entrepreneurship Development and IPR	2

Course Outcomes

At the end of the course:	
1	The students will learn to develop and manage new project/start-up.
2	The students will be able to use management skills for success of business venture.

Bibliography:

S. No.	Book Detail	Year of Publication
1	“Entrepreneurship”, TrehanAlpana, Dreamtech Press/Wiley India Publication.	2018
2	“Management Principles and Practice”, Srinivasan R. and Chunawalla S.A., Himalaya Publishing House.	2017
3	“Essentials of Management: International and Leadership Perspective”, WeihrichH.and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012

4	“The New Era of Management”, Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	“Principles & Practice of Management”, Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2015
6	“Management: Text and Cases”, Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
7	“Management: Concept, Practice and Cases”, Aswathappa K. and GhumanKarminder, Pubs: McGraw Hill Education.	2010
8	“Dynamics of Entrepreneurial Development & Management”, Desai V., 5th Edition, Pubs: Himalaya Publishing House.	2012
9	“Projects: Planning, Analysis, Selection, Financing, Implementation and Review”, Chandra P., 8th Edition, Pubs: McGraw-Hill Education (India).	2014
10	“Entrepreneur’s Toolkit”, Harvard Business School, Pubs: Harvard University Press.	2004
11	“Essentials of Project Management”, Ramakrishna K, Pubs: PHI Learning.	2010
12	Harvard Business Review: Entrepreneur’s Handbook	2018
13	WIPO Annual Publications	

Course Name	:	Professional Ethics
Course Code	:	SSM 5023
Credits	:	0.5
L T P	:	0-3-0
Segments	:	6

Total No. Tutorials:- 07

Course Objectives:

- | |
|---|
| 1. The main aim of this course is to provide basic knowledge about ethics, values, norms and standards and their importance in professional life. |
|---|

Course Contents:

S. No.	Course Contents	No. of Tutorials
1.	Introduction to Ethics: Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics.	2
2.	Self-Awareness & Self Development: Concept of Self Awareness – Need, Elements, Self-Assessment – SWOT Analysis, Self-Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem, Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation	2
3.	Ethics and Business: Concept of Business Ethics – Nature and Objectives. Ethical dilemmas in business ethics.	1
4.	Professionalism in engineering and its relation to ethics: Ethics in Practice: Professional accountability, Roles of Professionals.	2

Course Outcomes:

At the end of the course:	
1	The students will be able to distinguish between right and wrong in both personal and professional life.
2	The students will learn about their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities.

Bibliography:

S. No.	Book Detail	Year of Publication
1.	“Business Ethics – Text and Cases”, Murthy C.S.V., 1 st Edition, Pubs: Himalaya Publishing House.	2014
2.	“The Curse of Self: Self-awareness, Egotism and the Quality of Human Life”, Leary M.R., 1 st Edition, Pubs: Oxford University Press.	2007
3.	“Business Ethics”, Hartman L.P. and Chatterjee A., 3 rd Edition, Pubs: Tata McGraw Hill	2006
4.	“Business Ethics and Professional Values”, Rao A.B., Pubs: Excel Books	2006
5.	“Business Ethics – Concepts and Cases”, Velasquez M.G., 5 th Edition, Pubs: Prentice Hall	2001
6.	“Issues and Ethics in the Helping Professions”, Corey G., Corey M.S. and Callanan P., 8 th Edition, Pubs: Brooks/Cole, Cengage Learning	2010
7.	“Theories of Personality”, Hall C.S., Lindzey D. and Cambell J.B., 4 th Edition, Pubs: Hamilton Printing Company	1997

Program Core-I&II

Course Name	:	Advanced Traffic Engineering
Course Code	:	CEM 5013
Credits	:	03
LTP	:	2 0 2
Segments	:	1-6

Total No. of Lectures: 28
Total No. of Lab Hours: 28

Course Objectives:	
The main objectives of the course are	
1.	To understand the concepts of characterizing traffic and various modelling approaches
2.	To be able to design the facilities to control and manage traffic.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Traffic Characteristics and Traffic studies: Introduction to Traffic Engineering, Traffic characteristics, Traffic studies: Volume, Speed, Origin and destination, Parking, Accidents, Lighting, Capacity and Level-of-service.	6
2	Traffic Control devices: Various Traffic Control devices, Principles of Intersection Design, Design of signalized, un-signalized intersections, and signal coordination	5
3	Traffic Regulations and Statistical methods:	5
4	Traffic Flow Theory: Fundamentals of Traffic flow theory, Macroscopic and Microscopic Traffic flow models, Shockwave Analysis, Car following theory, Queuing Theory, Vehicle arrival, Gap and Gap acceptance	6
5	Simulation of Traffic Systems and introduction to Intelligent Transport system: Introduction to Intelligent transportation systems, Travel and Traffic management, Public transportation operations, Electronic payment, Advanced vehicle control and safety systems, Emergency management, ITS Architecture, National ITS architecture, ITS Planning	6

Lab Work:

S. No.	Lab contents	No. of Hours
1	Project-1: Make evaluation of the level of service at an urban intersection and determine if it is good or bad.	04
2	Project-2: Check the traffic volumes of an urban stretch and determine whether an additional lane is required or not.	04
3	Project3: Evaluate the signs on a road stretch and see if it fulfils the warrants for putting it	04
4	Project4: Conduct of traffic simulation	04

5	Project5: Studies on safety performance under mixed traffic	04
6	Project6: Compute the impact of bicycles on the traffic flow	04
7	Project7: Assessment of Parking demand of an urban area	04

Course Outcomes:

At the end of the course the students will be able to:	
1.	Understand the traffic components and characteristics
2.	Efficiently conduct traffic surveys and use the Traffic survey analysis for management of traffic, designing existing and new road infrastructure
3.	Develop ability to design various types of intersections, Implementation of Traffic Control devices and traffic regulations
4.	Gain confidence in studying Applications of Traffic flow theories to solve congestion problems and to use simulation techniques.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Kadiyali, L. R., Traffic Engineering and Transport Planning,. Khanna Publishers	2011
2	Khanna S.K., Justo C.E.G. and Veeraragavan A., “Highway Engineering”, 10 th Edition, Nem Chand and Bros. Roorkee	2015
3	O’Flaherty C A, “Transport Planning and Traffic Engineering”, Butterworth Heinemann, Elsevier, Burlington, MA	2006
4	Mannering Fred L., Kilarski Walter P. and Washburn Scott S., Principles of Traffic Engineering and Traffic Analysis, Third Edition, Wiley	2007
5	Roess, R. P., Prassas, E. S., and McShane, W. R., Traffic Engineering, 4th Edition, Prentice Hall	2010
6	ChakrobortyPartha and Animesh Das, Principles of Transportation Engineering, Prentice hall	2005

Course Name	:	Pavement Analysis And Design
Course Code	:	CEM 5023
Credits	:	3
LTP	:	2 0 2
Segments	:	1-6

Total No. of Lectures: - 28
Total No. of Lab Hours: 28

Course Objectives:	
The main objectives of the course are:-	
1.	To inculcate the in-depth knowledge of analysis and design of pavement structure
2.	To enhance the understanding of pavement evaluation, maintenance and rehabilitation strategies

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Fundamentals of pavement design: Requirements of an ideal pavement, elements of pavement structure and their function. Type of pavements, comparison of flexible and rigid pavements, comparison of highway and airport pavements, factors affecting pavement design	4
2	Analysis and Design of Flexible pavements: Stress distribution phenomenon, AASHTO, Asphalt Institute AI, CBR, IRC design methods	8
3	Analysis and Design of rigid pavements: AASHTO, PCA and IRC design methods, Westergaard's analysis, wheel load stresses, temperature stresses and their evaluation, design of joints	8
4	Rehabilitation and Maintenance of pavements: Causes of failures of flexible pavements and remedial measures, causes of failures of rigid pavements and remedial measures, maintenance of pavements	4
5	Pavement evaluation and overlay design: Introduction, method of pavement evaluation, design principles of overlay, IRC design guidelines	4

Lab Work:

S. No.	Lab Contents	No. of Hours
1	Project-1: Estimation of Design MSA for a stretch of road	06
2	Project-2: Estimation of Design CBR	10
3	Project-3: Futuristic estimation of roadway requirement.	04
4	Project-4: Design example for flexible pavement	04
5	Project-5: Design example for rigid pavement	04

Course Outcomes:

At the end of the course the students will be able to:	
1.	Understand the different components of pavement structures.
2.	Gain confidence in designing flexible and rigid pavements.
3.	Study the of maintenance and Rehabilitation of Pavements.
4.	Have in depth knowledge of the pavement evaluation and design principles governing Overlay.

Bibliography:-

S No.	Name of Book/ Authors/Publishers	Year
1	L.R. Kadyali& N.B Lal ,Principles and practices of Highway Engineering	2006
2	Sharma S.K, “Principles, Practices and design of Highway Engineering”, S. Chand Publisher	2012
3	Khanna S.K., Justo C.E.G. and Veeraragavan A., “Highway Engineering”, 10 th Edition, Nem Chand and Bros. Roorkee	2015
4	Relevant IRC and AASHTO codes	
5	O’Flaherty, A. Coleman, “Highways : the Location, Design, Construction and Maintenance of Road Pavements”, 4th Ed., Elsevier	2006

Program Elective-I

Course Name	:	Geometric Design of Transportation Infrastructure
Course Code	:	CEM 5111
Credits	:	1.5
LTP	:	2 1 0
Segments	:	1-3

Total No. of Lectures: 14

Total No. of Tutorials: 07

Course Objectives:

The main objectives of the course are:	
1	To provide optimum efficiency in traffic operation and maximum safety at reasonable cost.
2	To gain an insight into the Modern modes of Transportation

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction : Geometric design provision for various transportation facilities as per IRC guidelines, geometric design of horizontal and vertical alignment	2
2	Design of at grade intersections : Principles of design, channelization, roundabouts, staggered intersections	3
3	Design of interchanges: Major and minor interchanges, entrance and exit ramps	3
4	Design of drainage facilities: Importance, Principles, drainage of various geometric elements, surface and subsurface drainage	2
5	Railway Planning and Design Bullet trains, HistoryTechnologyRouting Track Signal systemElectrical systemsTrainsTractionSafety recordsEconomicsEnvironmental impactChallenges encounteredridership future, Monorails introduction to mono rail systems history of monorail working principle types of transit system Construction advantages disadvantages monorails in India future scope	4

Course Outcomes:

At the end of the course the students will be able to :	
	Apply the Interpretation of geometric design fundamentals in the field.
	Confidently design at-grade and grade separated intersections along with design of drainage facilities.
	Understand the principles of geometric design for various transportation facilities.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1	Kadyali L.R. and Lal N.B., “Principles and Practices of Highway Engineering”, Khanna Publishers	2006
2	O’Flaherty, A. Coleman, “Highways: the Location, Design, Construction and Maintenance of Road Pavements”, 4 th Ed. , Elsevier	2006
3	C. JotinKhistya and B. Kent Lall, “Transportation Engineering”, by Prentice Hall of India Private Limited	2006
4	Relevant IRC Codes	
5	Pocket book of Highway Engineers	2002

Course Name	:	Advanced Soil Engineering
Course Code	:	CEM 5112
Credits	:	1.5
L T P	:	2-0-2
Segments	:	1-3

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of the course are:	
1.	To impart knowledge of engineering properties of various types of soils.
2.	To impart knowledge of latest trends in soil engineering.

S. No.	Course contents	No. of Lectures
1.	Origin, nature and distribution of soils: Engineering Behaviour of Soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits	2
2.	Consolidation: One, two and three dimensional and radial consolidation. Factors affecting shear behaviour. Determination of parameters. Pore-pressure parameters. Unconsolidated Undrained, Consolidated Undrained, Consolidated Drained tests. Total and effective stress paths.	3
3.	Geosynthetics: Types and functions; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures, Geosynthetics in Pavements; separations, drainage and filtering in road pavements.	3
4.	Methods of site investigations: Direct methods, semi-direct methods and indirect methods. Field tests: In-situ shear test, in-situ permeability test, Standard Penetration Test, Dynamic Cone Penetration Test, Codal provisions.	3
5.	Slope Stability analysis: Finite and infinite slopes, limit equilibrium methods. Bishop (Rigorous and Simplified) Method	3

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Consolidation Test	06
2.	Tri-Axial Test (UU, CU & CD)	06
3.	Demonstration of Static Penetration Test and Dynamic Cone Penetration Test	02

Course Outcomes:

At the completion of the course, students will be able to:	
1.	Ascertain the behaviour of soil as a construction material as supporting medium.
2.	To apply latest trends of soil engineering in construction.

Bibliography:

Sr. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Soil Mechanics,Lambe and Whitman,WileyInterscience Publication, New Jersey	2000
2.	Reinforced soil and its engineering application, Swami Saran, I.K. International, New Delhi	2013
3.	Physical and geotechnical properties of soils,Bowles, McGraw Hill Education, New York	1984
4.	Design aids in soil mechanics and foundation engineering,KanirajS.K.,McGraw Hill Education, New York	2017

Classical Books:

S. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Soil Mechanics in Engineering Practice, Terzaghi and Peck, John Wiley and Sons, New Jersey	1948
2.	Soil Engineering, Alam Singh, CBS Publishers, New Delhi	2009

MOOCs on this course are available at:

- 1) <http://nptel.ac.in/courses/105104147/>
Course: Geology and Soil Mechanics
Professor: P. Ghosh, IIT Kanpur
- 2) <https://swayam.gov.in/courses/4386-soil-mechanics-geotechnical-engineering-i>
Course: Soil mechanics/geotechnical engineering
Professor: Dilip Kumar Baidya, IIT Kaharagpur

Course Name	:	Land Use & Regional Transportation Planning
Course Code	:	CEM 5113
Credits	:	1.5
LTP	:	2 1 0
Segments	:	1-3

Total No. of Lectures: 14

Total No. of Tutorials: 07

Course Objectives:

The main objectives of the course are:	
1	To enhance the knowledge about various land use models.
2	To understand the applications for policy formulation and evaluation.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Land Use transportation models: Urban forms and structures, Classification of Land Use Transport Models, Economic Base Mechanism, Allocation Mechanism and Spatial Allocation and Employment Relationships.	4
2	Regional and intercity travel demand estimation: Factors affecting Goods and Passenger Flows, Use of Mathematical Models to estimate Freight and Passenger Demand.	3
3	Regional network planning: Problems in Developing Countries, Network Characteristics- Circuitry, Connectivity, Mobility, Accessibility using GIS and Level of Service Concepts, Rural road Network Planning.	3
4	Policy formulation and evaluation: Application of Land Use Forms and Structures at Urban and Regional Levels, Small Area Management, Residential Neighbourhood and Structure Planning.	4

Course Outcomes:

At the end of the course the students will be able to :	
1.	Understand various urban forms and structures.
2.	Develop awareness about various land use Transportation models.
3.	Have competency to estimate regional, intercity travel demand and freight travel demand which are useful for policy formulation

Bibliography:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Blundon, W. R. and J Black, The Land Use Transport System, 2nd Edition, Australian Natl Univ Press	1984
2	TomasDela Barra, Integrated Land Use and TransporationModelling, Cambridge University Press.	2010
3	Eric Koomen and Judith Borsboom-van Beurden, Land-Use Modelling in Planning Practice (GeoJournal Library), 1st Edition, Springer	2011
4	Chari S.R. Land Use Transportation Planning, Lecture Notes	2006

Course Name	:	Airport Infrastructure, Planning and Design
Course Code	:	CEM 5114
Credits	:	1.5
LTP	:	21 0
Segments	:	1-3

Total No. of Lectures: 14
Total No. of Tutorials: 07

Course Objectives:

The main objectives of the course are:	
1	To provide a basic understanding on Airport Infrastructures
2	To enhance the Knowledge of Systems Planning and Operations and their design.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction Air transport- structure and organization, the challenges and the issues.	2
2	Airport Planning Airport master plan, Aircraft characteristics	2
3	Planning and design of the terminal area The planning terminal system; design considerations and visual aids, Architectural view point of terminal planning	2
4	Structural design of airport pavements Design factors, Design of flexible pavements	2
5	Airport drainage Design runoff, inlet size and location design, surface and subsurface design, Solar system	2
6	Runway Design and Taxiway Design Introduction, Orientation of runway, Wind rose diagram type -1 and type-2, Basic runway length, Actual runway length and Basic pattern of runways. Introduction, Taxiway geometric design elements, Strength of taxiways, Rapid exit taxiways, Factors governing lay out of taxiways.	4

Course Outcomes:

On completion of the course the students should be able to:	
1	To develop awareness about the types of pavements and their design
2	To comfortably design the runway pavements.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Horonjeff , R. Mickelvey, F.X, Planning & design of airports, Mc Graw Hill, New York, 4 th edition.	2010
2	Khanna, S.K., Arora, M.G., and S.S. Jain; Airport Planning and Design, Nem Chand & Brothers	2012
3	Air transportation planning and design by Virender Kumar & Satish Chandra, Galgotia Publications, N.Delhi	2012

Program Elective-II

Course Name	:	Pavement Management System
Course Code	:	CEM 5211
Credits	:	1.5
LTP	:	2 1 0
Segments	:	4-6

Total No. of Lectures: 14
Total No. of Tutorials: 7

Course Objectives:

The main objectives of the course are:	
1	To enhance the knowledge about the design, evaluation and performance of existing and new flexible and rigid pavements
2	To sensitize the students about the emphasis on systems approach and performance prediction models.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction Pavement Management Systems; Components of pavement management systems	3
2	Pavement conditions survey and ratings	3
3	Pavement performance prediction Concepts, modelling techniques, Comparison of different deterioration models	3
4	Alternate pavement design Strategies and economic evaluation, Cycle tracks and approach for physically challenged (PwD)	3
5	Road asset management , pavement preservation programs, life cycle costing	2

Course Outcomes:

On completion of the course the students should be able to:	
1	Development of skills for macro and micro techno-economic management of wide area pavement network.
2	Gain confidence in designing, evaluation and performance of flexible and rigid pavements.
3	Develop awareness pavement management process, pavement evaluation and performance, design alternatives, analysis, evaluation and selection

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Haas, R., W.R. Hudson, and J.P. Zaniewski, "Modern Pavement Management", Krieger Press	1994
2	Yoder E.J. and Witezak, "Principles of Pavement Design," John Wiley & Sons	1975
3	Shahin M.Y. "Pavement Management for Air Port, Roads and Parking Lots", Chapman and Hall/Springer	2005
4	K.B Woods, Highway Engineering Handbook McGraw Hill	1960

Course Name	:	Intelligent Transportation Systems
Course Code	:	CEM 5212
Credits	:	1.5
LTP	:	2 1 0
Segments	:	4-6

Total No. of Lectures: 14

Total No. of Tutorials: 07

Course Objectives:	
The main objectives of the course are:	
1.	To familiarize the students with latest techniques of intelligent transportation systems
2.	To have an overview of the fundamentals of ITS implementation

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction to Intelligent Transportation Systems Overview, ITS user services, Travel and traffic management, Public transportation operations, Electronic payment, Commercial vehicle operations, Advance vehicle control and safety systems, Emergency management, Information management, Maintenance and construction management, Architecture of ITC, National ITS architecture, User services and their requirements, Logical architecture, Physical architecture, Equipment packages, Market package.	4
2	Intelligent Transportation Systems Planning Planning for ITS, Integrating ITS into Transportation planning, ITS Standards, Need of ITS standards, Classification of standards, Standards Testing and Evaluation- Traffic simulation models, ITS deployment analysis system.	5
3	Advanced Intelligent Transportation Systems Smart car, Smart road, Infrastructure to Infrastructure Communications, Vehicle to infrastructure communications, Vehicle to vehicle communications.	5

Course Outcomes:

On completion of the course the students should be able to:	
1.	To design and implement the application of Electronic Systems in Transportation,
2.	Develop the system of tackling the congestion in the various transportation modes.
3.	Understand the sensor and communication technologies.
4.	Develop awareness about the significance of ITS under Indian condition.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Chowdhury, M. A., and Sadek, A., Fundamentals of Intelligent Transportation Systems Planning, Artech House	2003
2	Sussman, J. M., Perspectives on Intelligent Transportation Systems (ITS), Springer	2005
3	Turban, E., and Aronson, J. E., Decision Support Systems and Intelligent Systems, 5th Edition, Prentice Hall	2004

Course Name	:	Railway Infrastructure, Planning and Design
Course Code	:	CEM 5213
Credits	:	1.5
LTP	:	2 1 0
Segments	:	4-6

Total No. of Lectures: 14

Total no. of Tutorials: 07

Course Objectives:
The main objectives of the course are:-
1. To expose the various aspects of planning and design of Rail Transportation Systems.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Rail transportation Planning and Geometric design of track Importance, rail transportation as compared to other means of transport, project analysis and design, alignment survey through GIS, introduction to bridges and tunnels	4
2	Railway accidents and Disaster Management Train accidents; classification of accidents; Derailment and its causes; safety measures	5
3	Suburban railways in Metro cities Urban transport; MRTS in Delhi	5

Course Outcomes:

At the completion of this course, students will be able to:-
1. Develop awareness about design of rail track, permanent way stations and yards
2. Gain knowledge about MRTS in metro cities.
3. Be confident about the geometric design of track, railways in metro cities and modernization of railways.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Railway Engineering by Rangwala	2008
2	Chandra S. and Aggarwal M.M., Railway Engg	2007
3	Saxena S.C. and Arora S.P., Railway Engineering Dhanpat rai	1981
4	Hay, W.W Railway Engineering John Wiley and Sons, New York	1982
5	Victor D.J Essential of Bridge Engineering Oxford & I.B.H. Publishing Co., New Delhi	1973

Course Name	:	Remote Sensing And GIS
Course Code	:	CEM 5214
Credits	:	1.5
LTP	:	2.5-0.5-0
Segments	:	4-6

Total No. of Lectures: 17

Total No. of Tutorials: 04

Course Objectives:

The main objectives of the course are:-	
1	To introduce the students to the recent techniques of Remote Sensing and GIS
2	To sensitize the students to the applications of Remote sensing and GIS in Traffic and Transportation Engineering.

Course Contents:

S. No.	Course Contents	No. Of Lectures
1	Modern Trends In Surveying And Mapping in Transportation Engineering Digital Mapping, Uses and applications, data collection techniques (Conventional and Non-conventional), Present Status in India and abroad	2
2	Aerial Photogrammetry Introduction, types, Stereoscopy, Scale of a photograph, flight planning, Mosaics	2
3	Geographical Information System (GIS) Introduction, advantages, Definition, Components, Digital Elevation Model, Applications of GIS related to Transportation Engineering	2
4	Introduction to Remote Sensing (RS) Introduction, Ideal & Real RS System, Visual Image interpretation, Active and passive remote sensing, Reflectance, Spectral Reflectance Curves, Resolution	2
5	Digital Image Processing (DIP) Introduction, Histogram, Radiometric errors and Geometric errors, Image classification – Supervised and Unsupervised classification, Applications	3
6	Global Positioning System for Transportation Engineering Introduction, GPS, DGPS	2
7	Applications of Remote Sensing & GIS Route optimisation, Shortest route, Best Route etc.	2
8	Software Demonstrations And Working GIS/RS software	2

Course Outcomes:

At the completion of this course, students will be able to:-	
1	To develop awareness amongst the students in recent advancements in surveying.
2	Competence to understand various terms in Geospatial Industry and relate with the applications of RS/GIS in Smart City initiatives.
3	To develop confidence among the students with concept of digital mapping, to make them aware of recent advancements/software in Remote Sensing, GIS for utilization in transportation projects.

Bibliography:-

S.No.	Book Name & Publisher	Year of Publishing
1	Geomatics Engineering, Manoj Arora & R C Barjatiya, Nem Chand Brothers, Roorkee.	2011
2	Principles of GIS, Peter A. Burrough, Rachael A., Oxford University Press	2014
3	Remote Sensing and Image Interpretation, Lillesand and Kiefer, Wiley Publishers	2010
4	Introduction to GIS, Kang-tsung, Tata McGraw Hill, 5th Edition	2016
5	Introduction to Remote Sensing, Campbell & Wynne, Guilford Press	2014

MOOCs on this course are available at:

1. <https://www.coursera.org/spatial-analysis> (Course on Geospatial and Environmental Analysis, University of California, Davis)

Engineering Mathematics

Engineering Mathematics 1 (EM1)

Course Name	:	FOURIER TRANSFORMS
Course Code	:	EMM 5011
Credits	:	01
L T P	:	2-1-0
Segments	:	1-2

Total No. of Lectures– 10, Tutorials -5

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the concept of Fourier transform and be able to compute it for standard examples.
2	To make the students able to apply Fourier transforms to solve differential equations and partial differential equations.

Course contents:

Sr.No	Course Contents	No. of Lectures
1	Fourier Transforms: Fourier Integral formulas, Definition and examples, Basic properties, Fourier cosine and sine transforms and examples, Basic properties of Fourier cosine and sine transforms, Multiple Fourier transforms.	05
2	Fast Fourier Transforms and Short Term Fourier Transforms: Definition and examples, Basic properties, Applications.	05

Course Outcomes:

At the end of the course, students will be able to:	
1	Solve differential equations by using Fourier transforms
2	Solve partial differential equations by using Fourier transforms
3	Apply FFT and STFT to engineering problems

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	“Integral Transforms and Their Applications”, LoknathDebnath, CRC Press, Inc.,	1995.
2	“Integral Transforms and their Applications”, Brian Davies, 3rd Edition, Springer-Verlag, New York, Inc,	2001
3	“Fourier Transform and Its Applications”, Ronald N. Bracewell, 2nd Edition, McGraw-Hill Inc., US,	1986

Engineering Mathematics 2 (EM2)

Course Name	:	NUMERICAL METHODS
Course Code	:	EMM 5013
Credits	:	01
L T P	:	2-0-2
Segments	:	3-4

Total No. of Lectures – 10, Practical -10

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the basics of numerical methods.
2	To make the students able to solve problems on system of linear equations and Interpolation by numerical methods.

Course contents:

S. No.	Course Contents	No. of Lectures
1	Error Analysis: Definition and sources of errors, Propagation of errors, Floating-point arithmetic and rounding errors.	02
2	Interpolation: Interpolation using Finite differences, Numerical Differentiation and Numerical integration, Trapezoidal and Simpson's rules.	04
3	Numerical Solution of Differential Equations: Picard's method, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method.	04

Lab Work:

S. No.	Lab. Contents	No. of Hours
1.	Solving Interpolation, Numerical Differentiation and Numerical integration problems using Mathematica.	04
2.	Solving Differential equations numerically using Mathematica.	06

Course Outcomes:

By the end of the course, the students will be able to solve the following by numerical methods:
<ol style="list-style-type: none"> 1. Problems on Interpolation 2. Problems on Differentiation, Integration. 3. Solve differential equations.

Bibliography:

Sr.No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	“Introduction to Numerical Analysis”, Atkinson K. E., John Wiley.	1989
2	“Applied Numerical Analysis”, Gerald C. F. and Wheatley P. O., Pearson	2004
3	“Numerical Methods for Scientific and Engineering Computation”, Jain M. K., Iyengar S.R.K. and Jain R. K., New Age International Publisher.	2004
4	“Elements of Numerical Analysis”, Gupta R.S., Macmillan India Ltd .	2008

Engineering Mathematics 3 (EM3)

Course Name	:	OPTIMIZATION TECHNIQUES
Course Code	:	EMM 5019
Credits	:	01
L T P	:	2-0-2
Segments	:	5-6

Total No. of Lectures – 10, Practical -10

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems.
2	To make the students able to identify and solve linear and non-linear models of optimization problems.

Course contents:

S. No.	Course Contents	No. of Lectures
1	Linear Programming: Formulation, Graphical solution, Simplex method.	04
2	Non Linear Optimization Techniques: Unconstrained problems - Necessary and sufficient conditions for extreme points, Newton's method, Gauss- Newton method, Parallel axis method. Constrained problems - Lagrangean method , KKT conditions, Nelder Mead method.	06

Lab Work:

S.No.	Lab. Contents	No. of Hours
1.	Solving linear problems using Mathematica/MATLAB.	04
2.	Solving non-linear problems using Mathematica/MATLAB.	06

Course Outcomes:

1	The students are able to form mathematical model of optimization problems.
2	The students are able to distinguish between linear and nonlinear models .
3	The students are able to solve simple problems using Mathematica/MATLAB

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	“Operations Research” ,Ravindran , Phillips , and Solberg , 2 nd edition, John Wiley & sons .	2000
2	“Engineering Optimization” , S S Rao , 3 rd edition, New Age .	2000
3	“Operations Research”, Kantiswarup, Gupta P.K. & Sultan Chand & Sons	2007
4	“Operations Research”, Sharma S.D., Kedarnath, Ramnath&Company .	1994
5	“Operations Research”, Bronson R, Shaum's Outline Series .	1997

Semester-II

Design of Experiments and Research Methodology

Course Name	:	Design of Experiments & Research Methodology
Course Code	:	DRM 5011
Credits	:	3
L T P	:	2-1-0
Segments	:	1-6

Course Objectives

The main Objectives of this course are:	
1	To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data collection and their interpretation.
2	To understand concept of research, need for research, types of research and steps in conducting research.

Total No. of contact hour: 42 (L= 28+T=14)

S.No	Course Content	No. of Lectures
1	Design of Experiment Principles of Experimental design, sampling methods, probability sampling	3
2	Modeling Introduction to modeling, types of models, development of mathematical models	4
3	Random variables Random variables and its properties, probability distributions, probabilistic model estimation and its assessment	6
4	Random Variables Data Analysis Single and multi variables data analysis, estimation of parameters, splinessmoothing, Residual analysis, Analysis of Variances	5
4	Random Variates Simulation, Monte Carlo Method, Queuing Theory, Markovian process	3
5	Geostatistics Introduction to Geostatistics, Geostatistical data analysis methods	3
6	Stochastic Processes Time series analysis, model identification, forecast and uncertainty analysis	2
7	Research Report Writing Research objectives formulation, literature collection, data analysis methods, report writing and conclusions	2

Course Outcomes

At the completion of this course, students will be able to:	
1	Students will be able to make use of various Research methodologies and its applications in the relevant field of engineering.
2	Organize and conduct research (advanced project) in a more appropriate manner

Bibliography		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, Pearson Education.	7th edition, 2002
2	Statistics in Research, BernandOstle and Richard N.Mensing, Oxford & IBH Pub Co.	3rd edition, 1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, John Wiley & Sons.	4th edition, 2003
4	Experimental design, Theory & application, Federer, Oxford & IBH pub Co.	1955
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

MOOCs on this course are available at:

1. <http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments>
By Prof. Paul Berger, MIT Professional Education
2. <https://nptel.ac.in/courses/107108011/>
By Prof. AmareshChakrabarti, Indian Institute of Science, Bangalore

Program Core-III

Course Name	:	Highway Materials Design And Construction
Course Code	:	CEM 5033
Credits	:	1.5
LTP	:	2-0-2
Segments	:	1-3

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:	
The main objectives of the course are:	
1	To introduce advance knowledge in highway materials:- granular, bituminous and cementitious; mix proportion design and construction for highway development,
2	To understand quality assurance, and economic selection of pavement materials for durable roads

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Soil sub-grade, soil stabilization and low cost road	2
2	Desirable characteristics of Road aggregates, proportioning of aggregates, Artificial aggregates, Sustainability and availability of sound aggregates	2
3	Types of bitumen, bitumen Constituents, characterization of bitumen, emulsions, modified bitumen	2
4	Desirable properties of bitumen mixes and design of bitumen mixes, mixes from recycled materials	2
5	Factors influencing and design of pavement grade concrete mixes, geopolymer concrete	2
6	Bituminous and concrete road construction Procedure and specification	2
7	Quality assurance-bituminous roads, concrete roads, codal guidelines	2

Lab Work:

S. No.	Lab contents	No. of Hours
1	Proportioning of soil, proportioning of aggregates	2
2	Characterisation of aggregates	2
3	Characterisation of bitumen	2
4	Testing of Bituminous mix	2
5	Testing of pavement grade concrete	2
6	Presentation on pavement construction equipment and methods	2
7	Presentation on Quality assurance in pavement construction	2

Course Outcomes:

At the end of the course the students will be able to:	
1.	Achieve techno-economic optimisation in selection of pavement materials to increase durability.
2.	Reduce cost with minimum adverse impact on environment

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Principles of Transportation engineering by Chakroborty& Das, Prentice Hall, India.	2009
2	Highway Engg by S.K Khanna & CEG Justo, Nem Chand Bros., Roorkee	2001
3	Principles and practices of Highway engg by L.R Kadyali, Khanna Publishers, Delhi.Edition 6	2013

MOOCs on this course is available at:

1. <https://nptel.ac.in/courses/105101087/23>

Course Name	:	Management of Transport Infrastructure Projects
Course Code	:	CEM 5034
Credits	:	1.5
LTP	:	3-0-0
Segments	:	4-6

Total No. of Lectures: - 21

Course Objectives:	
The main objectives of the course are:-	
1.	To understand risks in management of various Transportation Infrastructure projects
2.	To explore opportunities in management of various Transportation Infrastructure projects.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Construction Project Management: an Overview- Construction industry; construction project; product development process; project management ; main causes of project failure; BOT, BOOT, BORT, BOLT and other variants of BOT. causes of introducing this system, Liberalization policies of GOI for these system; GOI, state governments, other local bodies, board, corporation etc. are adopting these system for construction project management. Water Transport System in India	6
2	Project Management Information System : PMISconcept; PMIS framework; information system computerization; user's system specifications development; acquiring a system; problems in information system management; benefits of computerized information system	5
3	Risk management in infrastructure projects: Introduction; identification of risks: an important principle, task involvement, aspects to analyze; Stages of project implementation: gestation stage, development stage, construction stage, operational stage, termination stage; Specific categories of risk: revenue risk, design risk, construction risk, operating risk, financial risk, political risk, legal risk, environmental risk, force majeure risk.; allocation & management of risks: concept of risk management, management of risk, risk matrix.; Developers perspective of risk; Government's perspective of risk.	5
4	Construction Project Insurance policies: Introduction; storage cum erection and marine cum erection insurance, subject matter, insured party, cover ,sum insured, period of cover, deductible franchise, basis of claim settlement, extension of basic cover, risk distributor, marine cum erection.; contractor's all risk policy: introduction, scope of cover, main exclusions, sum assured , period of contract, basis of settlement of claims, various extensions of the policy, escalation, maintenance, claims procedure and documents, documents required	5

Course Outcomes:

At the end of the course the students will be able to:	
1.	Useful for project planning
2.	Useful for project administration
3.	Useful for project implementation

Bibliography:-

S No.	Name of Book/ Authors/Publishers	Year
1	Indian highways – a framework for commercialization by GajendraHaldia	2010
2	Risk management in construction projects NCP-centre of distance education for construction industry manager	2016
3	NHAI & CIDC websites with some national and international journals of construction field with the proceedings of conferences/ seminars organized by CIDC & NICMAR	2014
4	Construction Project Management by Col. K.K Chitkara Published by Tata Mcgraw Hill	2017

Program Core-IV

Course Name	:	Transportation System Planning And Management
Course Code	:	CEM 5043
Credits	:	3
LTP	:	2-0-2
Segments	:	1-6

Total No. of Lectures: 28
Total No. of Lab Hours: 28

Course Objectives:	
The main objectives of the course are:	
1	To study the various techniques of transportation management
2	To study the various techniques of performance of various transportation systems

Course Contents:

S. No.	Course Contents	No. of Lectures
1	General Importance of transportation, transportation planning methodology, hierarchical levels of planning and its relation to rural, urban areas. Long range planning, Passenger and goods transportation, General concept and process of transport planning, Land-use transport interactions, Socio-economic characteristics of Land use	5
2	Transportation Systems Multi modal transportation system; Characteristics of Mass Transit systems including technical, demand operational and economic problems, Mass Rapid Transit System-Elevated, Surface and Underground construction , Express Bus System, Operating Characteristics of Terminal and Transfer facilities	5
3	Urban Transportation Planning Studies Urban Travel Characteristics, Transportation demand Surveys, Delineation of the urban area, zoning, Origin-Destination Studies, Home Interviews, trip Classification and Socio- Economic variables in trip making projections	5
4	Planning Methodology and Systems analysis Study of existing network-trip generation techniques, Category analysis, multiple regression techniques, Trip distribution techniques, Growth Factor model, Gravity models, Opportunity models and multiple regression models, Traffic assignment methods, Minimum Path tree-All or nothing assignment	6

Lab Work:

S. No.	Lab contents	No. of Hours
1	Study of Pattern of road systems	4
2	Origin and Destination Studies for construction of bye passes	8
3	Home Interview technique application in an urban area	8
4	Projection of demand of Transportation of a new area	8

Course Outcomes:

At the end of the course the students will be able to:	
1.	Gain Knowledge of various systems of transportation.
2.	Have an in depth knowledge of Demand projection techniques of various transportation systems.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers	2011
2	Highway Engg.-Khanna S.K. and Justo C. E. G. New Chand Publication	2008
3	C A O'Flaherty, "Transport Planning and Traffic Engineering", Butterworth Heinemann, Elsevier, Burlington, MA	2006
4	Transportation Engineering and Planning, by C. S. Papacostas and P. D. Prevedouros, Prentice Hall of India Private Limited	2001

MOOCs on this course is available at:

1. <https://nptel.ac.in/courses/105107067/>

Program Elective-III

Course Name	:	Transportation Economics And Finance
Course Code	:	CEM 5411
Credits	:	1.5
LTP	:	3-0-0
Segments	:	1-3

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1	To know Economic evaluation of transportation projects, ownership financing of transport and economic function of transportation.
2	To gain an insight into road user and transportation cost, finance and taxation.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Economic evaluation of transport plans Need for economic evaluation, cost and benefits of transport projects, time horizon in economic assessment, basic principles of economic evaluation, interest rate, method of economic evaluation, benefit cost ratio method, first year rate of return, net present value method, internal rate of return method, comparison of various methods of economic evaluation.	5
2	Vehicle operating costs Introduction, road user cost study in India , components of VOC, factors affecting VOC, fuel consumption relationship, spare parts consumption, maintenance and repairs, labour cost, tyre life, lubricants, utilization, and fixed costs.	4
3	Value of travel time savings Introduction, classes of transport users enjoying travel time savings, methodology for monetary evaluation of passengers' travel time, review of work in India on passengers' travel time.	3
4	Accident costs Introduction, relevance of accident costing for a developing country, review of alternative methodologies for accident costing, Indian studies.	3
5	Traffic congestion, traffic restraints and road pricing Congestion as a factor in road traffic, traffic restraint, road pricing.	3
6	Highway finance Basic principles, distribution of highway cost, sources of revenue, highway financing in India.	3

Course Outcomes:

At the end of the course the students will be able to :	
1.	Analyse transportation project case studies.
2.	Evaluate transportation project case studies.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1	Principles of Transportation engineering by Chakroborty & Das, Prentice Hall, India.	2009
2	Highway Engg by S.K Khanna & CEG Justo, Nem Chand Bros., Roorkee	2001
3	Principles and practices of Highway engg by L.R Kadyali, Khanna Publishers, Delhi. Edition 6	2013
4	Principles of Transportation and Highway engg by G.V Rao, Tata Mc Graw-Hill Publishing Co.Ltd. N.Delhi	1996
5	HarralClell G., A Manual for the Economic Appraisal of Transport Projects, World Bank Report, Washington D.C	2006

MOOCs on this course is available at:

<https://nptel.ac.in/courses/105104098/45>

Course Name	:	Ground Improvement Techniques
Course Code	:	CEM 5312
Credits	:	1.5
L T P	:	3-0-0
Segments	:	1-3

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1.	Know the need and objectives of ground improvement techniques.
2.	Comprehend the principles of various ground improvement methods.
3.	Compare different methods of ground improvement and understand their suitability.
4.	Apply the relevant method to remedy a difficult soil condition.
5.	Learn the issues affecting design and construction of various methods for soil improvement.

S. No.	Course contents	No. of Lectures
1	Unit – I Introduction to Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques - suitability and feasibility, Emerging Trends in ground improvement. Mechanical Modification; Principles and methods of soil compaction, Compaction control, Compaction piles, dynamic compaction, Vibroflot technique, controlled blasting for compaction.	5
2	Unit – II Physical and chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Grout materials, Grouting techniques and control.	4
3	Unit – III Hydraulic Modification: Methods of dewatering, open sumps and ditches, Well-point system, Electroosmosis, Vacuum dewatering; Pre-loading without and with sand drains, strip drains and rope drains. Geo-textiles: Types of Geo-textiles, Woven and non-woven fabrics, Geo-membranes, Geo-grids, Geocomposites, Geo-nets, Functions and applications, Properties of geo-textiles.	7
4	Unit – IV Reinforced Earth: Concept of soil reinforcement, reinforcing materials, Backfill criteria, Design and construction of reinforced earth structures. In-Situ Ground Treatment for slopes: Soil nailing, Rock anchoring, Micro-piles, design methods, construction techniques; Gabion walls, Crib walls.	5

Course Outcomes:

At the completion of the course, students will be able to:	
1.	Apply the principles of ground improvement to a given site condition.
2.	Work out the choice of right technique to improve different difficult grounds.
3.	Ensure safe, stable and economical construction for any structure.

Bibliography:

Sr. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Robert M. Koerner - Construction and Geotechnical methods in Foundation Engineering McGraw-Hill Pub. Co., New York.	2010
2.	Winterkorn and Fang - Foundation Engineering Hand Book - Van Nostrand Reinhold Co., New York.	2008
3.	Aris C. Stamatopoulos&Panaghiotis C. Kotzios - Soil Improvement by Preloading – John Wiley & Sons Inc. Canada.	2008

MOOCs on this course is available at:

<https://nptel.ac.in/courses/105108075/>

Course Name	:	Advanced Foundation Engineering
Course Code	:	CEM 5313
Credits	:	1.5
L T P	:	3-0-0
Segments	:	1-3

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1.	To learn the different types of foundation and their suitability for particular site and structure.
2.	To understand soil-structure interaction and calculation of allowable load and settlement of the foundation

Course Contents:

S.No.	Course Contents:	No. of Lectures
1.	Shallow Foundations: Design considerations- factors of safety (including limit state), allowable settlements, location and depth of foundations, Codal provisions, Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, Plate load tests.	6
2.	Deep foundations: Type of Piles. Construction methods. Axial capacity of single piles-static formulae, Skin friction and end bearing in sands and clays. Axial capacity of groups, Codal provisions. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Caissons and Wells.	5
3.	Soil structure interaction: Introduction to soil-foundation interaction problems, soil behaviour , Foundation behaviour, Interface behaviour, Soil Foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.	4
4.	Soil Liquefaction and remedial measures, stone column, vibrofloatation, deep compaction.	3
5.	Foundations in difficult soils: Expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence.	3

Course Outcomes:

At the completion of the course, students will be able to:	
1.	Decide the type of foundation required for a particular site and structure.
2.	Make geotechnical design of the foundations for civil engineering structures under varied field conditions.

Bibliography:

S.No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Foundation Analysis and Design, Joseph E. Bowles, Mc-Graw Hill Publications	1997
2.	Design aids in soil mechanics and foundation engineering, Kaniraj S.K., Mc-Graw Hill Publications	1988
3.	Pile Foundation Analysis and Design, Poulos H.G. and Davis, E.H., John Wiley,1980.	1980

MOOCs on this course are available at:

1. <https://nptel.ac.in/courses/105105039/>
By Prof.Kousik Deb,Indian Institute of Technology, Kharagpur
2. <https://freevidelectures.com/course/2674/foundation-engineering>
By Prof.N.K.Samadhiya,Indian Institute of Technology, Roorkee
3. <https://www.surrey.ac.uk/postgraduate/advanced-geotechnical-engineering-msc-2018>
By Prof.S.Bhattacharya,University of Surrey, England

Program Elective-IV

Course Name	:	Docks and Harbour Engineering
Course Code	:	CEM 5411
Credits	:	1.5
LTP	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1	To develop a fundamental understanding of Port and Harbour Engineering and its necessity.
2	To visualize the relationship between Site Considerations and its Planning of Harbours.
3	To know about the various Design Elements of On-Shore and Off-Shore Structures.
4	To know about the various procedures available for sediment transport and dredging.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	General: History, development and policy, classification of harbours, major ports in India, administrative set up, harbour economics	2
2	Harbour Planning: Harbour components, ship characteristics, characteristics of good harbour, and principles of harbour planning, size of harbour, site selection criteria and layout of harbours.	3
3	Natural Phenomena: Wind, waves tides and currents phenomena, their generation characteristics and effects on marine structures, silting, erosion and littoral drift.	2
4	Marine Structures: General design aspects, breakwaters - function, types general design principles, wharves, quays, jetties, piers, pier heads, dolphin, fenders, mooring accessories-function, types, suitability, design and construction features.	3
5	Docks and Locks: Tidal basin, wet docks-purpose, design consideration, operation of lock gates and passage, repair docks - graving docks, floating docks, marine railway.	3
6	Port Amenities: Ferry, transfer bridges, floating landing stages, transit sheds, ware houses, cold storage, aprons, cargo handling equipments, purpose and general description.	3
7	Navigation Aids: Channel and entrance demarcation, buoys, beacons, light house electronic communication devices.	2

Course Outcomes:

On completion of the course the students should be able to:	
1	Develop an understanding of overall Port and Harbour Engineering and its impact.
2	Absorbs the Key design Characteristics for design of Elements like Groins, Break waters, jetties etc.
3	Fully conversant with advanced topics like Deck and Fenders, Dolphins etc.
4	Acquire a basic understanding flow regime, lift force mechanism, bed load and suspended load etc.

Bibliography:-

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Garde, R.J. and Ranga Raju, K.G., Mechanics of Sediment Transportation and Alluvial stream problems, Second Edition, Wiley Eastern Limited, 46254/21, Daryaganj, New Delhi.	2006
2	Graf, H.W., Hydraulics of Sediment Transport, McGraw Hill Book Co. New York 1971.	2003
3	Dock and Harbour Engineering Vols. I – IV by A.D.F. Quinn.	1987
4	Design & Construction of ports and Marine structures by Alanzo De F.Quinn.	1999

MOOCs on this course is available at:

<https://nptel.ac.in/courses/114106025/>

Course Name	:	Bridge Engineering
Course Code	:	CEM 5412
Credits	:	1.5
LTP	:	3-0-0
Segments	:	1-3

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1	To familiarize with the types, suitability, selection, design criteria of various types of bridges.
2	To understand the Analysis and Design of various types of bridges and construction methods.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	General Bridge systems: Considerations in alignment, Planning, Economic considerations, Aesthetics and selection of type of bridge, Bridge Hydrology, Scour Depth, Depth of foundation, Estimation of Design Discharge	3
2	Loading Standards: Specifications for loading, geometrical proportioning etc. Road, Rail-cum-Road bridges, Indian Road Congress and Indian Railway loading standards and their comparison with loading standards followed in U.K., U.S.A. and Europe.	3
3	Design of Bridges: Reinforced Concrete Bridges, Slab culverts, T-Beam Bridges, Box Girder Bridges	4
4	Bridge Bearings	3
5	Design of sub structure - Piers and Abutments.	3
6	Design considerations for pre-stressed bridges, trussed steel	3
7	Limit State concept for Design of RCC bridges.	2

Course Outcomes:

At the end of the course the students will be able to :	
1.	Understand the design philosophy of various types of bridges
2.	Understand the construction technique of various types of bridges

Bibliography:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Bridge Superstructure, N. Rajagopalan, Narosa Publishing House	2006
2	Bridge Engineering Handbook, W. F. Chen and L. Duan, CRC press	2003
3	Structural Bearings, H. Eggert and W. Kauschke, Ernst & Sohn	2002
4	Design of Bridges, N.Krishna Raju, Oxford and IBH Publications	1988
5	Victor D.J, Essential of Bridge Engineering Oxford & I.B.H. Publishing Co., New Delhi.	2001

Course Name	:	Road Safety Engineering
Course Code	:	CEM 5413
Credits	:	1.5
LTP	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:
The main objectives of the course are:-
1. To understand and analyse the factors that may influence traffic safety on roads
2. To incorporate engineering measures for traffic safety

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction to safety: road accidents, trends, causes, collision and condition diagrams, highway safety, human factors, vehicle factors.	02
2	Road safety management system: multi-causal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, safety data needs.	03
3	Statistical interpretation and analysis of crash data: before-after methods in crash analysis, advanced statistical methods, black spot identification & investigations, case studies.	05
4	Road safety audits: key elements of a road safety audit, road safety audits & investigations, crash investigation and analysis, methods for identifying hazardous road locations, case studies.	05
5	Crash reconstruction: describe the basic information that can be obtained from the roadway surface, understand basic physics related to crash reconstruction , speed for various skid, friction, drag, and acceleration scenarios, variables involved, in jump and flip crashes, variables involved in pedestrian crashes, case studies.	04
6	Mitigation measures: accident prevention by better planning, accident prevention by better design of roads, crash countermeasures, highway operation and accident control measures, highway safety measures during construction, highway geometry and safety.	02

Course Outcomes:

At the completion of this course, students will be able to:-	
1	To analyze the effect of driver characteristics, roadway characteristics, climatic factors on highway safety.
2	To plan and design a road safety improvement program.
3	To analyze accident data and suggest safety measures.
4	To conduct road safety audit and interpret accident data using statistical analysis.

Bibliography:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	IPC SO 088-2010 Manual on Road Safety Audit, Indian Road Congress, New Delhi	2010
2	Khanna S.K, Justo CEG and Veeraragman A. , Highway Engineering, New Chand and Brothers, 10 th Edition, 2015	2015
3	Garber N.J and Hoel L.A, Principles of Traffic and Highway Engineering, Cengage Learning India Pvt. Ltd, 2009	2009
4	Khisty C.J and LallB.Kent, Transportation Engineering – An Introduction, Pearson, 3 rd Edition, 2017	2017

Open Elective

Course Name	:	Transportation and Environment
Course Code	:	CEO 5007
Credits	:	1.5
LTP	:	3-0-0
Segments	:	1-3

TotalNo. of Lectures: 21

Course Objectives:

The main objectives of the course are:-	
1	To know how the transportation systems are polluting the environment
2	To understand the necessity of EIA studies for highways taking various case studies.

Course Contents:

S. No.	Course Contents	No. Of Lectures
1	Introduction Classification, effects of air pollutants on humans, plants and materials	3
2	Vehicular emissions Sources, meteorology and photochemical reactivity of pollutants; Monitoring and control measures of automobile emissions	4
3	EIA studies of highways and ambient air quality standards	6
4	Noise measurements, noise levels and noise control Effects of transportation noise, road traffic noise, train and rail noise, aircraft noise; Active noise control, vibration control principles; Noise survey; Environmental Impact Statements and case studies on noise control	6
5	Introduction to sustainable Transportation infrastructure	2

Course Outcomes:

At the completion of this course, students will be able to:-	
1	Learn about measures for controlling pollution for various transportation systems.
2	To be aware of various environmental regulations.

Bibliography:-

S. No.	Book Name & Publisher	Year of Publishing
1	C. S Rao, "Environmental Pollution Control Engineering", Wiley	2000

	Eastern Limited	
2	Mukherjee, “Environmental Pollution and Health Hazards, Causes and Effects”	1986
3	M. N. Rao, H.V.N Rao, Air Pollution, Tata McGraw Hill Pvt. Ltd. New Delhi	1993
4	Antony Milne, “Noise Pollution: Impact and Counter Measures”, David and Charles	2006

MOOCs on this course is available at:

<https://nptel.ac.in/courses/105101008/43>

Course Name	:	Road Safety Engineering
Course Code	:	CEO 5008
Credits	:	1.5
LTP	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:
The main objectives of the course are:-
1. To understand and analyse the factors that may influence traffic safety on roads
2. To incorporate engineering measures for traffic safety

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction to safety: road accidents, trends, causes, collision and condition diagrams, highway safety, human factors, vehicle factors.	02
2	Road safety management system: multi-causal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, safety data needs.	03
3	Statistical interpretation and analysis of crash data: before-after methods in crash analysis, advanced statistical methods, black spot identification & investigations, case studies.	05
4	Road safety audits: key elements of a road safety audit, road safety audits & investigations, crash investigation and analysis, methods for identifying hazardous road locations, case studies.	05
5	Crash reconstruction: describe the basic information that can be obtained from the roadway surface, understand basic physics related to crash reconstruction , speed for various skid, friction, drag, and acceleration scenarios, variables involved, in jump and flip crashes, variables involved in pedestrian crashes, case studies.	04
6	Mitigation measures: accident prevention by better planning, accident prevention by better design of roads, crash countermeasures, highway operation and accident control measures, highway safety measures during construction,	02

	highway geometry and safety.	
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Course Outcomes:

At the completion of this course, students will be able to:-	
1	To analyze the effect of driver characteristics, roadway characteristics, climatic factors on highway safety.
2	To plan and design a road safety improvement program.
3	To analyze accident data and suggest safety measures.
4	To conduct road safety audit and interpret accident data using statistical analysis.

Bibliography:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	IPC SO 088-2010 Manual on Road Safety Audit, Indian Road Congress, New Delhi	2010
2	Khanna S.K, Justo CEG and Veeraragman A. , Highway Engineering, New Chand and Brothers, 10 th Edition, 2015	2015
3	Garber N.J and Hoel L.A, Principles of Traffic and Highway Engineering, Cengage Learning India Pvt. Ltd, 2009	2009
4	Khisty C.J and LallB.Kent, Transportation Engineering – An Introduction, Pearson, 3 rd Edition, 2017	2017