

CURRICULUM AND DETAILED SYLLABI

FOR

DEGREE (Infrastructure Engineering and Management) PROGRAM

FIRST TO FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2019-2020



THIAGARAJAR COLLEGE OF ENGINEERING
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Autonomous Institution affiliated to Anna University)
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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF CIVIL ENGINEERING

Vision

To establish process of learning to meet the global standards for sustainable built environment

Mission

We are committed to:

- Provide quality education through innovation in teaching and learning practices meeting the global standards
- Encourage faculty and students to carry out socially relevant and forward looking research
- Offer consultancy services using state of the art facilities fulfilling the needs of the industry and society
- Enable our students, faculty and staff to play leadership roles for the betterment of the society in a sustainable manner.

Programme Educational Objectives (PEOs) for M.E Infrastructure Engineering & Management programme:

- PEO 1)** Graduates will apply management and economic theories to formulate strategies to enable organizations to achieve their goals
- PEO 2)** Graduates of the programme will serve as project leaders with critical-thinking and analytical decision-making capabilities.
- PEO 3)** Graduates will be capable of integrating their knowledge of multi-disciplines of management to analyze construction industry problems and recommend action thereon
- PEO 4)** Graduates of the programme will contribute as team members adding value through innovation, customer focus, prudence, and professional responsibility, consistent with the objectives of the projects in which they are involved and the organizations they support

Programme Outcomes (POs) of M.E Infrastructure Engineering & Management programme:

The Graduate Attributes of PG programmes of the NBA are as following:

PO1. Scholarship of Knowledge

Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2. Critical Thinking

Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3. Problem Solving

Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4. Research Skill

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5. Usage of modern tools

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6. Collaborative and Multidisciplinary work

Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7. Project Management and Finance

Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

PO8. Communication

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9. Life-long Learning

Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10. Ethical Practices and Social Responsibility

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11. Independent and Reflective Learning

Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback

Programme Specific Objectives (PSOs) of M.E. (Infrastructure Engineering and Management)

PSO1	Investigate and manage infrastructure projects by formulating strategies using critical thinking, analytical decision making and multi- disciplinary competencies
PSO2	Work and lead the infrastructure project through innovation, commitment, professional and ethical accountability; aligning with its objectives

Department of Civil Engineering
M.E Infrastructure Engineering and Management - Schedule of courses

Semester	Theory Courses					Theory cum Practical	Laboratory	Project	Credits
	1	2	3	4	5	6	7	8	
1 st	18IM110 Applied Statistics and Optimization (FC) (3 credits)	18IM120 Traffic Engineering and Management (PC1) (3 credits)	18IM130 Material Procurement and Management (PC2) (3 credits)	18IM140 Quantitative Methods in Managem ent (PC3) (3 credits)	---	18IM160 Project Formulation and Implementation (PC4) (3 Credits)	18IM170 Traffic Engineering Lab (Lab1) (2 credits – 4 hours)	---	17
2 nd	18IMPX0 (PE1) (3 credits)	18IMPX0 (PE2) (3 credits)	18IMPX0 (PE3) (3 credits)	18IMPX0 (PE4) (3 credits)	18PG250 Common Core – (2 credits)	18IM260 Project Management (PC5) (3 credits)	18IM270 Building Information Modeling Lab (Lab2) (2 credits – 4 hours)	18IM280 Mini Project (2 credits)	21
3 rd	18IMPX0 (PE5) (3 credits)	---	---	---	18PGPX0 Open Elective (2 credits)	---	---	18IM380 Dissertation Phase I (10 credits)	15
4 th	---	---	---	---	---	---	---	18IM480 Dissertation Phase II (15 credits)	15
Total credits for curriculum activities									68

FC- Foundation Core, PC – Programme Core, PE – Programme Elective

A student has to complete 2 audit courses of 24 hours duration. The courses will normally be conducted on week-ends

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015**M.E Degree (Infrastructure Engineering and Management) Program****COURSES OF STUDY**

(For the candidates admitted from 2018-2019 onwards)

FIRST SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
18IM110	Applied Statistics and Optimization	FC	2	1	0	3
18IM120	Traffic Engineering and Management	PC	3	0	0	3
18IM130	Material Procurement and Management	PC	3	0	0	3
18IM140	Quantitative Methods in Management	PC	2	1	0	3
18IM160	Project Formulation and Implementation	PC	2	0	2	3
PRACTICAL						
18IM170	Traffic Engineering Lab	PC	0	0	4	2
Total			12	2	6	17

SECOND SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
THEORY						
18IMPX0	Programme Elective-I	PE	2	1	0	3
18IMPX0	Programme Elective-II	PE	2	1	0	3
18IMPX0	Programme Elective – III	PE	3	0	0	3
18IMPX0	Programme Elective – IV	PE	3	0	0	3
18PG250	Common Core	PC	2	0	0	2
18IM260	Project Planning and Control	PC	2	0	2	3
PRACTICAL						
18IM270	Building Information Modeling Lab	PC	0	0	4	2
18IM280	Mini Project	PC	0	0	4	2
Total			14	2	10	21

THIRD SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
THEORY						
18IMPX0	Programme Elective – V	PE	3	0	0	3
18PGPX0	Open Elective	PE	2	0	0	2
PRACTICAL						
18IM380	Dissertation Phase-I	PC	0	0	20	10
Total			5	0	20	15

FOURTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
18IM480	Dissertation Phase-II	PC	0	0	30	15
Total			0	0	30	15

** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; FC- Foundation Core; PC- Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC- Two Credit Course; SS-Self-Study Course (in the list of Programme Electives)

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015**M.E Degree (Structural Engineering) Program****SCHEME OF EXAMINATIONS**

(For the candidates admitted from 2014-2015 onwards)

FIRST SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	18IM110	Applied Statistics and Optimization	3	50	50	100	25	50
2	18IM120	Traffic Engineering and Management	3	50	50	100	25	50
3	18IM130	Material Procurement and Management	3	50	50	100	25	50
4	18IM140	Quantitative Methods in Management	3	50	50	100	25	50
5	18IM160	Project Formulation and Implementation	3	50	50	100	25	50
PRACTICAL								
7	18IM170	Traffic Engineering Lab	3	50	50	100	25	50

SECOND SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuou s Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	18IMPX0	Programme Elective-I	3	50	50	100	25	50
2	18IMPX0	Programme Elective-II	3	50	50	100	25	50
3	18IMPX0	Programme Elective – III	3	50	50	100	25	50
4	18IMPX0	Programme Elective – IV	3	50	50	100	25	50
5	18PG250	Common Core	3	50	50	100	25	50
6	18IM260	Project Planning and Control	3	50	50	100	25	50
PRACTICAL								
7	18IM270	Building Information Modeling Lab	3	50	50	100	25	50
8	18IM280	Mini Project	3	100	50	100	25	50

THIRD SEMESTER

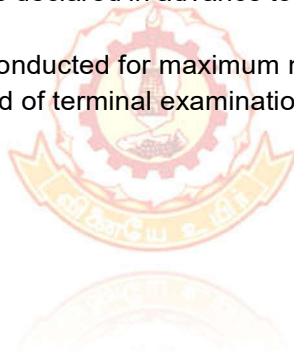
S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	18IMPX0	Programme Elective – V	3	50	50	100	25	50
2	18PGPX0	Open Elective	3	50	50	100	25	50
PRACTICAL								
3	18IM380	Dissertation Phase-I	-	50	50	100	25	50

FOURTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PRACTICAL								
1	18IM480	Dissertation Phase-II	-	150	150	300	75	150

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.



LIST OF ELECTIVES

Sl.No	Subject Code	Course Name
1	18IMPA0	CONTRACTS AND ARBITRATION
2	18IMPB0	STRATEGIC PLANNING FOR INFRASTRUCTURE SECTORS
3	18IMPC0	MANAGEMENT OF HUMAN RESOURCE, SAFETY AND QUALITY
4	18IMPD0	CONSTRUCTION EQUIPMENT MANAGEMENT
5	18IMPE0	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT
6	18IMPF0	TRANSPORTATION PLANNING
7	18IMPG0	INFRASTRUCTURE FINANCE
8	18IMPH0	SUSTAINABLE DEVELOPMENT
9	18IMPJ0	URBAN PLANNING AND DESIGN
10	18IMPK0	REMOTE SENSING AND GIS
11	18IMPL0	ORGANIZATIONAL BEHAVIOUR
12	18IMPM0	URBAN ENVIRONMENTAL MANAGEMENT
13	18IMPN0	GEOTECHNIQUES FOR INFRASTRUCTURE
14	18IMPP0	CONSTRUCTION MATERIALS AND TECHNOLOGY
15	18IMPQ0	LARGE SCALE SYSTEMS PLANNING

LIST OF OPEN ELECTIVES

SI.No	Course Name
1	Business Analytics
2	Industrial Safety
3	Operations Research
4	Cost Management of Engineering Projects
5	Composite Materials
6	Waste to Energy

LIST OF AUDIT COURSE 1 & 2

SI.No	Course Name
1	English for Research Paper Writing
2	Disaster Management
3	Sanskrit for Technical Knowledge
4	Value Education
5	Constitution of India
6	Pedagogy Studies
7	Stress Management by Yoga
8	Personality Development through Life Enlightenment Skills
9	Value Engineering

18IM110

**APPLIED STATISTICS AND
OPTIMIZATION**

Category	L	T	P	Credit
BS	2	1	0	3

Common to 18EN110**Preamble**

The correlation refers to the techniques used in measuring the closeness of relationship between the variables. When three or more variables are studied, it is a problem of either multiple or partial correlation. Estimators refer to the problem of determining the functions of sample observations such that the distribution is concentrated as closely as possible near the true value of the parameter. A statistical hypothesis is a quantitative statement about the probability distribution characterizing a population which we want to verify on the basis of information available from a sample. Non-Parametric or distribution free methods that often assume no knowledge whatsoever about the distributions of the underlying populations, except perhaps that they are continuous. In design of experiments we consider some aspects of experimental design briefly and analysis of data from such experiments using analysis of variance techniques.

Prerequisite

Probability and Statistics

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency Level (Grade)
CO1	Calculate the value which relates the dependent variable to one or more independent variables	Apply	65	B
CO2	State a statistical inference from information contained in random samples about the populations from which the samples were obtained	Understand	75	A
CO3	Estimate the characteristic of the population with degree of confidence from the random sample	Apply	80	A
CO4	Determine the most reliable results of the population based on all the information available in a sample using non-parametric methods	Apply	75	A
CO5	Calculate the experimental error and hence to control the extraneous variables involved in the experiment	Apply	90	A

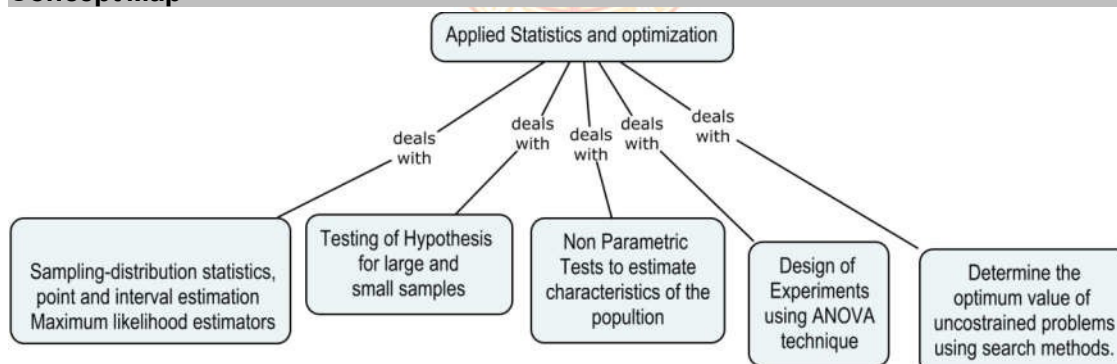
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1.	-	-	-	S	-	-	-	-	-	-	-	M	L
CO2.	-	-	S	-	M	-	-	-	-	-	-	S	M
CO3.	-	-	-	M	-	-	-	-	-	-	-	S	M
CO4.	-	M	-	-	S	-	-	-	-	-	-	S	L
CO5.	-	-	-	-	M	-	-	-	-	-	-	S	L
CO6.	-	-	S	M	-	-	-	-	-	-	-	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	20	10	10
Understand	30	20	20	20
Apply	60	60	70	70
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Concept Map**Syllabus**

Sampling Distribution & Estimation, Sampling-distribution statistics, Standard error, point and interval estimation for population mean, variance, Maximum likelihood estimators.

Testing of Hypothesis Testing of hypothesis-inferences concerning to means, variances and proportions, t-test, Chi-Square test, F-test. **Non Parametric Tests** Sign test of paired data, Rank Sum test, Mann Whitney U-test, Kruskal Wallis test, One sample run test, Kolmogorov-Smirnov test.

Design of Experiments Analysis of Variance-One way classification, Two way classification, Block randomized design, Latin Square design

Unconstrained Optimization Techniques Univariate Method, Pattern search Method, Descent Method, Steepest Descent Method.

Reference Books

1. Irwin Miller, John E.Freund "Probability and Statistics for Engineers" Prentice Hall of India Pvt. Ltd.; New Delhi, 1977.
2. S.S Rao "Optimization Techniques". Wiley Eastern Ltd.; 1992.

3. T.Veerarajan "Probability, Statistics and Random Processes" Tata McGraw-Hill, New Delhi, 2003.
4. Ronald E.Walpole, Sharon L.Myers "Probability and Statistics for Engineers and Scientists". Eighth Edition, Pearson education, New Delhi, 2007.

Course Contents and Lecture Schedule

S.No	Topics	No.of Lectures
Sampling Distribution & Estimation		
1.1	Sampling-distribution statistics, Standard error	2
	Tutorial	1
1.2	Point and interval estimation for population mean & variance, Maximum likelihood estimators	2
	Tutorial	1
Testing of Hypothesis		
2.1	Testing of hypothesis-inferences concerning to means, variances and proportions	2
	Tutorial	1
2.2	t-test	1
2.4	Chi-Square test, F-test	2
	Tutorial	1
Non Parametric Tests		
3.1	Sign test of paired data	1
3.2	Rank Sum test	2
	Tutorial	1
3.3	Mann Whitney U-test, Kruskal Wallis test	2
	Tutorial	1
3.4	One sample run test, Kolmogorov-Smirnov test	2
	Tutorial	1
Design of Experiments		
4.1	Analysis of Variance-One way classification	1
4.2	Two way classification	1
	Tutorial	1
4.3	Block randomized design	1
	Tutorial	1
4.4	Latin Square design	1
	Tutorial	1
Unconstrained Optimization Techniques		
5.2	Univariate Method, Pattern search Method	2
	Tutorial	1
5.3	Descent Method, Steepest Descent Method	2
	Tutorial	1
Total		36

Course Designers:

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**18IM120 TRAFFIC ENGINEERING AND
MANAGEMENT**

 Category L T P Credit
 PC 3 0 0 3

Preamble

Reliable and efficient traffic engineering management is crucial in our daily lives. This course imparts the student's, importance of transportation, various traffic engineering studies and traffic flow characteristics. The students will also acquire proficiency in the design of traffic facilities and also in efficient traffic management techniques. Further, students will be exposed to road safety aspects and studies.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency Level (Grade)
CO1	Identify various traffic engineering studies	Apply	80	A
CO2	Explain traffic flow and its characteristics	Apply	80	A
CO3	Design traffic facilities	Apply	80	A
CO4	State principles of road signs, markings and street furnitures	Understand	80	A
CO5	Identify road safety requirements	Apply	80	A
CO6	Explore techniques for traffic management	Understand	80	A

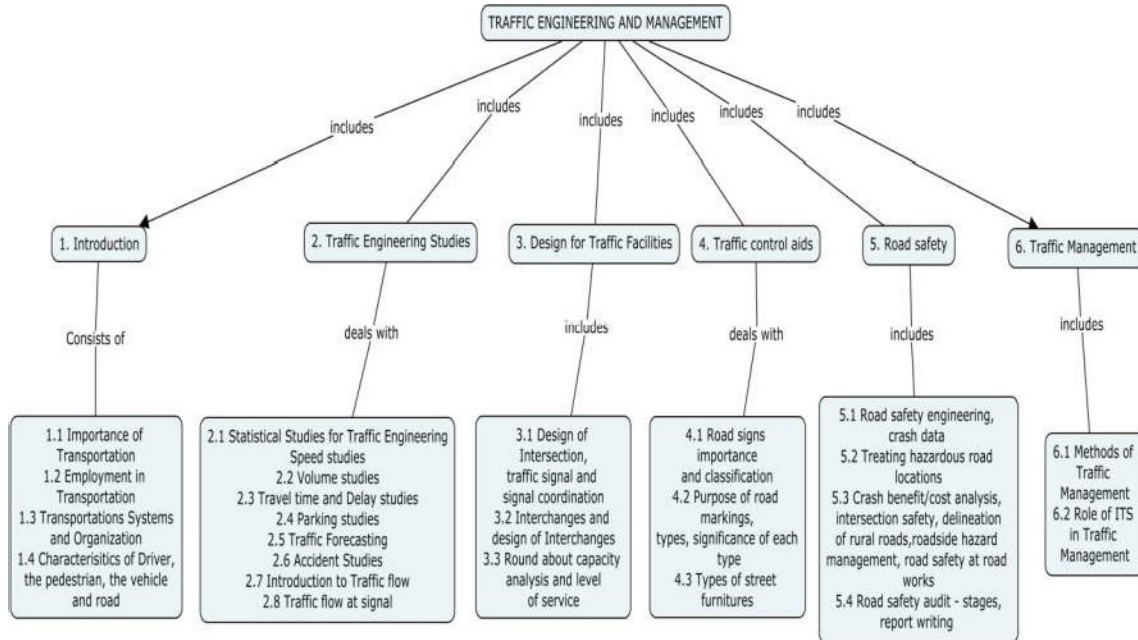
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	M	S	S	-	M	-	L	M	S	-	M	L
CO2	S	L	-	-	-	M	M	-	-	-	-	M	L
CO3	S	M	S	S	-	M	M	L	M	S	-	S	M
CO4	S	M	S	S	-	M	-	-	M	S	-	S	M
CO5	S	L	-	-	-	M	M	-	M	-	M	M	L
CO6	S	L	-	-	M	-	-	-	-	-	-	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Concept map**Syllabus**

Introduction Importance of transportation, Transportation systems and organisation. Characteristics of Driver, the pedestrian, the vehicle and road. (problems). **Traffic Engineering Studies** Statistical studies for traffic engineering; speed studies – volume studies – travel time and delay studies – parking studies – traffic forecasting. Accident studies.(concepts and problems)Traffic Flow - Introduction to traffic flow theory- Traffic flow at signalised and un-signalised intersection. **Design For Traffic Facilities** Intersection design, Design of traffic signal and signal coordination. Intersection design, signalized design – Interchanges – Design of interchange – round about, capacity analysis and level of service (concepts and problems).**Traffic Control aids** - road signs, road markings, street furnitures. **Road safety**- Road safety engineering, importance of good crash data, treating hazardous road locations (blackspots), crash benefit/cost analysis, intersection safety, delineation of rural roads, roadside hazard management, road safety at road works, Traffic management plan (TMP), Road Safety Audit – stages of audit, technical report writing. **Traffic management systems** - methods and techniques for traffic management - role of ITS in trafficmanagement.

References

1. Kadiyali L.R, "Traffic Engineering and Transportation Planning" Khanna Publishers, Delhi, 2005.
2. Khanna SK Justo CEG and Veeraragavan A, "Highway Engineering", Nem Chand & Bros, Roorkee, 2014.
3. Brase/Brase "Understandable Statistics 3rd edition", D C Health and Company, Lexington, Massachusetts, Toronko, 1987.
4. Jason C.yu, Transportation Engineering: Introduction to Planning, Design and Operations, Elsevier, 1992.

5. Taylor M.A.P and Young W, Traffic Analysis-New Technology and New solutions, Hargreen Publishing Company, 1998.
6. Nicholas J. Garben and Lester A Hoel, "Traffic and Highway Engineering", PWS Publication, 1999.
7. <http://www.nptel.ac.in/downloads/105101008/>

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Introduction	
1.1	Importance of Transportation	1
1.2	Employment in Transportation	1
1.3	Transportation Systems and Organization	1
1.4	Characteristics of Driver and the Pedestrian	1
1.5	Characteristics of the Vehicle and Road (Problems)	2
2.0	Traffic Engineering Studies	
2.1	Statistical studies for Traffic Engineering, Speed studies	1
2.2	Volume Studies	1
2.3	Travel time and Delay Studies	1
2.4	Parking Studies	1
2.5	Traffic Forecasting	1
2.6	Accident Studies (concepts and problems)	2
2.7	Traffic Flow - Introduction to Traffic Flow Theory	1
2.8	Traffic Flow at signal and unsignal intersection	2
3.0	Design for Traffic Facilities	
3.1	Intersection Design, design of traffic signal and signal coordination, signalized design	2
3.2	Interchanges - Design of Interchange	2
3.3	Grade Separator	1
3.4	Round about, capacity analysis and level of service (concepts and problems).	2
4.0	Traffic control aids	
4.1	Road signs importance and classification	1
4.2	Purpose of road markings, types, significance of each type	1
4.3	Types of street furnitures	1
5.0	Road safety	
5.1	Road safety engineering, crash data	1
5.2	Treating hazardous road locations	1
5.3	Crash benefit/cost analysis, intersection safety, delineation of rural roads, roadside hazard management, road safety at road works	2
5.4	Road safety audit – stages, report writing	2
6.0	Traffic Management	
6.1	Methods and techniques for traffic management	2
6.2	Role of ITS in traffic management	2
	TOTAL HOURS	36

Course Designers:

1. Dr. R. Velkennedy

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18IM130**MATERIAL PROCUREMENT
MANAGEMENT**Category L T P Credit
PE 3 0 0 3**Preamble**

This course focuses on the core principles of project procurement management, material planning and evaluation methods of materials consumed in various infrastructure domains. Students are exposed to effective techniques for successfully allocating risks and delivering projects which help in acquiring future projects.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will:

COs	Description	Bloom's Level	Expected Attainment Level (%)	Expected Proficiency Level (Grade)
CO1	Identify the need and role of material management	Understand	80	A
CO2	Classify materials, identify sources of procurement, conduct vendor analysis	Apply	80	A
CO3	Exercise control for effective management of inventory	Apply	80	A
CO4	Manage stores and exercise quality control on materials	Apply	80	A
CO5	Apply MMS in planning, procurement, inventory and cost control, evaluate projects and manage risks	Apply	80	B

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	-	-	-	-	-	L	-	L	-	-	M	L
CO2	M	M	M	-	S	-	S	S	L	S	M	M	L
CO3	M	S	M	L	-	S	S	M	L	S	M	S	M
CO4	M	S	M	M	-	S	S	S	L	S	M	S	S
CO5	M	S	M	S	-	S	S	M	L	S	M	S	S

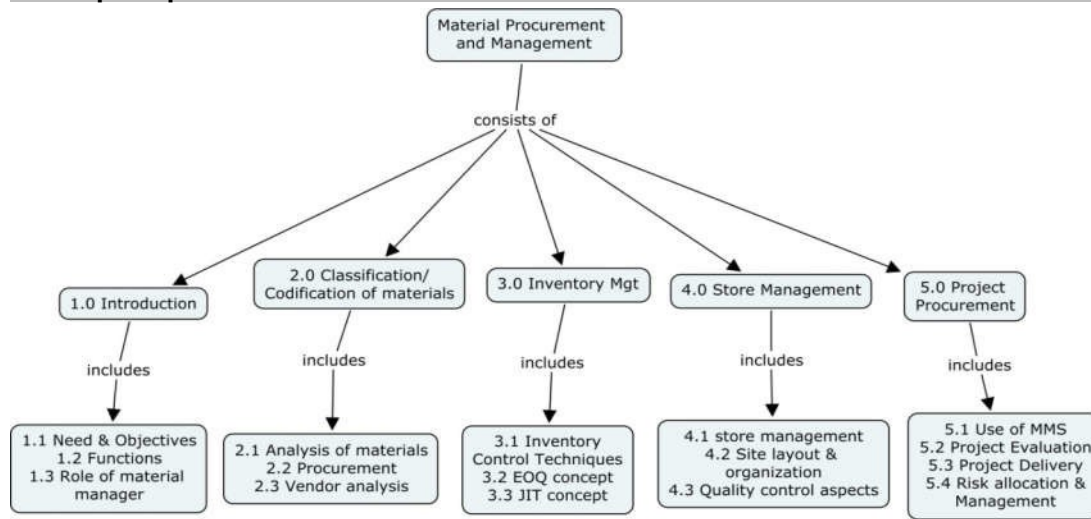
S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	0	0	0	0

Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Introduction: Importance of material management and its role in construction industry, scope, objectives and functions, Integrated approach to materials management, Role of materials manager. **Classification and Codification of materials of construction:** ABC, FSN, VED, SOS analysis - Procedure and its use, Standardization in materials and their management, Procurement - Identification of sources of procurement, vendor analysis. Materials Requirement Planning (MRP), Purchase procedure, legal aspects. **Inventory Management** – Store Purchase Manual, Contractors Obligation, Inventory Control techniques. EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control, safety stock, stock outs, application of ABC analysis in inventory control, Just In Time (JIT) Management, Indices used for assessment of effectiveness of inventory management. **Stores Management:** Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing, site layout and site organization, scheduling of men, materials and equipment. **Quality Control** – Conventional methods of quality control of Construction materials. Statistical method of quality control, sampling techniques in quality control process. Quality management and its economics. **Project procurement processes.** Materials Management Systems (MMS) and its scope in materials planning, procurement, inventory control, cost control etc. **Project evaluation:** Discounted Cash Flow, Real Options Theory. Project delivery methods, Competitive bidding. Risk allocation and management. Integrated project delivery. Contract negotiation.

References

1. "A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fourth Edition, An American National Standard, ANSI/PMI 990001-2008"
2. Chitale A.K. and R.C. Gupta, "Material Management – Text and Cases", Prentice Hall of India Pvt. Ltd., 2007
3. Denise Bower, "Management of Procurement", Construction Management Series, Thomas Telford Publishing, 2003
4. Joseph Philips, PMP, Project Management and Professional (Certification Study Guides), McGraw Hill Publication, 2013
5. Jhamb L.C., "Inventory Management", Everest Publishing house, 2005
6. Menon K.S., "Purchasing and Inventory Control", Wheeler Publication, 1993
7. Ministry of Rural Development, GOI, "Procurement Manual", National Rural Livelihoods Project, 2010

Course Contents and Lecture Schedule		
Module No.	Topic	No. of Lectures
1.0	Introduction to Material Procurement and Management	
1.1	Need and Importance of material management and its role in construction industry	1
1.2	Scope, objectives and functions of material management, Integrated approach to materials management	2
1.3	Role of materials manager	
2.0	Classification and Codification of Materials of Construction	
2.1	ABC, FSN - Procedure and its use	1
	VED, SOS analysis - Procedure and its use	2
2.2	Standardization in materials and their management, Procurement, Identification of sources of procurement	2
2.3	Vendor analysis concept of (MRKP) Material requirement planning, planning, purchase procedure, legal aspects	2
3.0	Inventory Management	
3.1	Inventory Control techniques – principle and applications	2
3.2	EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control,	2
	Safety stock, stock outs, application of AC analysis in inventory control	2
3.3	Concept of Just in time management(JIT), Indices used for assessment of effectiveness of inventory management	1
4.0	Stores Management	
4.1	Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing,	2
4.2	Site layout and site organization, scheduling of men, materials and equipment.	2
4.3	Quality Control – Conventional methods of quality control of Construction materials. Statistical method of quality control	2
	Sampling techniques quality control in process. Quality management and its economics	2
5.0	Project procurement	
5.1	Project procurement processes: Use of (MMS) – Materials Management Systems in materials planning,	2
	Procurement, inventory control, cost control	2
5.2	Project evaluation: Discounted Cash Flow, Real Options Theory. Project delivery methods, Project delivery methods. Competitive bidding	2
5.3	Project Delivery: Integrated Project Delivery	2
5.4	Risk Allocation and Management, Contract Negotiation	2
	Public Private Partnerships	1
Total Hours		36

Course Designers:

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18IM140

**QUANTITATIVE METHODS IN
MANAGEMENT**Category L T P Credit
PC 2 1 0 3**Preamble**

Decision making in today's social and business environment has become a complex task. The uncertainty of the future and the nature of competition and social interaction greatly increase the difficulty of managerial decision making. This course work on quantitative methods is an aid to decision making which offers the decision-maker a method of evaluating every possible alternative by using various techniques to know the potential outcomes.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Detail (COs)	Bloom's Level	Expected Attainment level (%)	Expected Proficiency Level(grade)
(CO1)	Formulate problems mathematically using the concept of Linear Programming (LP)	Apply	75	B
(CO2)	Solve LP problems by graphical, Simplex methods, Duality concept and identify the special cases in obtained solution	Apply	75	A
(CO3)	Solve transportation, assignment and traveling salesman problems	Apply	80	A
(CO4)	Apply Dynamic Programming to shortest route problems, capital budgeting problems and LPP	Apply	75	A
(CO5)	Apply game and decision theories to problems and understand the principle of Monte-Carlo simulation	Apply	75	B

Mapping with Programme Outcomes

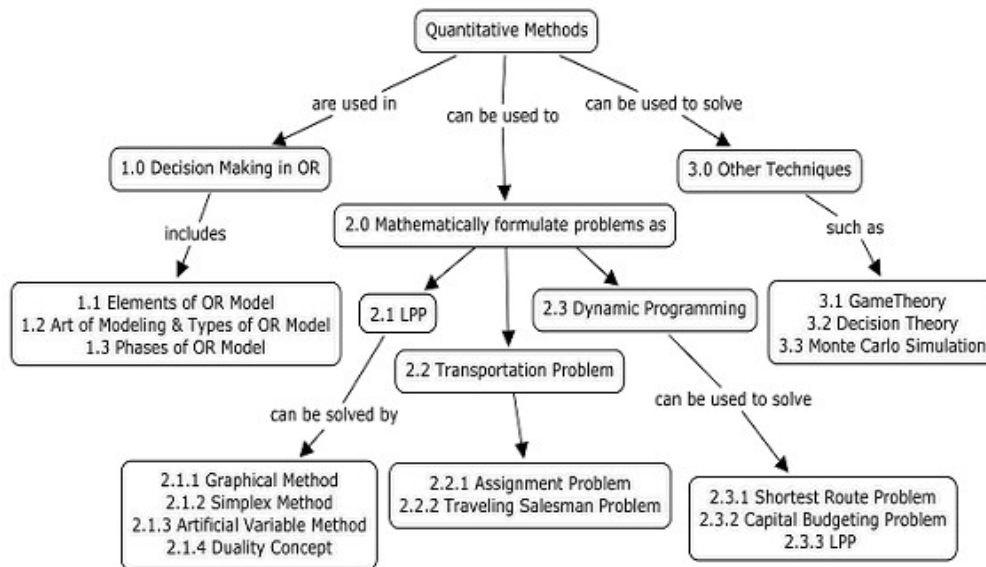
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO3.	S	S	M	S	-	-	M	-	-	M	M	S	M
CO4.	S	S	S	S	-	L	S	-	-	M	L	S	I
CO3	M	M	S	M	-	M	S	-	-	S	L	S	L
CO4	M	M	S	M	-	M	S	-	-	S	L	S	L
CO5	M	M	S	L	L	M	S	-	-	S	L	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	10
Understand	20	20	20	20
Apply	60	60	60	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Mathematical Modeling in OR: Decision Making in Operations Research. The art and science of Operations Research- Elements of a decision model- art of modeling- Types of models- effect of data available on modeling- computations in OR- Phases of OR study.

Systems Design: Problem formulation- conversion of statement problems into LPP standard format. **Linear Programming Problem:** Definition and properties of Linear Programming Problem, Standard form- Graphical solution of two variable problems, special cases. Simplex method - computational procedure & problems. Artificial variables - Big M and two phase Techniques, Special cases in Simplex method. **Linear Programming Applications:** Duality concept, primal & dual properties. Transportation problems - Vogel's Approximation method, Determination of optimum solution. Assignment Problem- Hungarian method of solution, Traveling salesman problem. Applications to Civil Engineering problems.

Dynamic Programming: Multistage decision process, Bellman's principle of optimality – Computational procedure – Illustrating Tabular method of solution – Computational procedure- Shortest route problem, Capital budgeting problem – Solution of Linear Programming Problem by Dynamic Programming. **Other Techniques:** Game theory – procedure and problems, Decision theory- procedure and problems. Simulation – Monte Carlo simulation – brief concept

References

1. Hamdy A. Taha, "Operations Research, An Introduction", Prentice Hall of India Pvt. Ltd., New Delhi-2013
2. S.S. Rao, "Optimization- Theory and Applications", New Age International (P) Ltd., Publishers 2001
3. P.D. Charbra, "Computer Oriented Optimization Techniques for Traffic and Transportation systems", Khanna Publishers, 1997
4. N. Krishna Raju and K.U. Muthu, "Numerical Methods in Engineering Problems", McMillan India Ltd., 1996

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Decision Making in OR	
1.1	Optimization – meaning. Elements of OR Model	1
1.2	Art of modeling and types of OR models	
1.3	Phases of OR model	
2.0	Mathematical Formulation of OR	
2.1	Linear Programming Problem- Definition and properties of Linear Programming Problem, Standard form	1
2.1.1	Graphical solution of two variable problems- Special cases	
2.1.2	Simplex method - computational procedure & Problems	2
	Tutorial	2
2.1.3	Artificial variable Technique– M technique- procedure and problems	2
2.1.3	Artificial variable Technique -Two phase technique- procedure & problems	2
	Tutorial	2
2.1.4	Duality concept- Primal & dual properties, Conversion of primal to dual problems	2
2.1.5	Special cases in Simplex method – Degeneracy, Alternative optima, Un-bonded solution, infeasible solution	1
	Tutorial	2
2.2	Transportation problems	
2.2	Transportation problems- objectives- Vogel's Approximation method, Determination of optimum solution	2
2.2.1	Assignment Problem- objective, Hungarian method of solution – problems	2
2.2.2	Traveling salesman problem- concept and procedure- Problems	
	Tutorial	2
2.3	Dynamic Programming	
2.3.1	Multistage decision process– Bellman's principle of optimality - Computational procedure – Illustrating Tabular method of solution Shortest route problem – computational procedure - Problems	2
2.3.2	Capital budgeting problem – Computational procedure – Problems	2
2.3.3	Solution of Linear Programming Problem by Dynamic Programming – problem	2
	Tutorial	2
3.0	Other techniques	
3.1	Game theory – procedure and problems	1
3.2	Decision Theory - procedure and problems	1
3.3	Simulation – Monte Carlo simulation – brief concept	1
	Tutorial	2
	Total Periods (24+12)	36

Course Designers:

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18IM160	PROJECT FORMULATION AND IMPLEMENTATION	Category	L	T	P	Credit
		PC	2	0	2	4

Preamble

This theory cum practical course is designed to give an exposure on the theoretical concepts of project formulation, appraisal, finance and implementation of infrastructure projects. This course also aims to apply the theoretical knowledge to practical problems. It also gives an overview on planning, estimate project cost, assessment methods, analyze risk and private sector participation in infrastructure development projects.

Prerequisite

Nil

Course Outcomes

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

COs for Theory part:

COs	Description	Blooms Levels	Expected Attainment level (%)	Expected Proficiency Level (grade)
CO1	Enumerate the need and procedure for project formulation	Apply	75	A
CO2	Analyse the feasibility of the project	Analyze	75	B
CO3	Understand the various sources of finance and key financial indicators in project financing	Understand	75	B
CO4	Enumerate the methods of risk analysis in projects	Apply	75	B
CO5	Apply knowledge on contract types in infrastructure projects and suggest solutions to possible contractual problems	Apply	75	B

COs for Practical part:

COs	Description	Blooms Levels	Expected Proficiency Level	Expected Attainment Level
CO1	Identify and formulate project to develop feasibility report	Apply	75	A
CO2	Analyse the profitability of a project in terms of its capital investment	Apply	75	B
CO3	Identify suitable sources of finance and perform risk analysis	Apply	75	B
CO4	Select appropriate contract for project implementation	Apply	75	A
CO5	Prepare tender and contract document for project	Apply	75	B

Mapping with Programme Outcomes

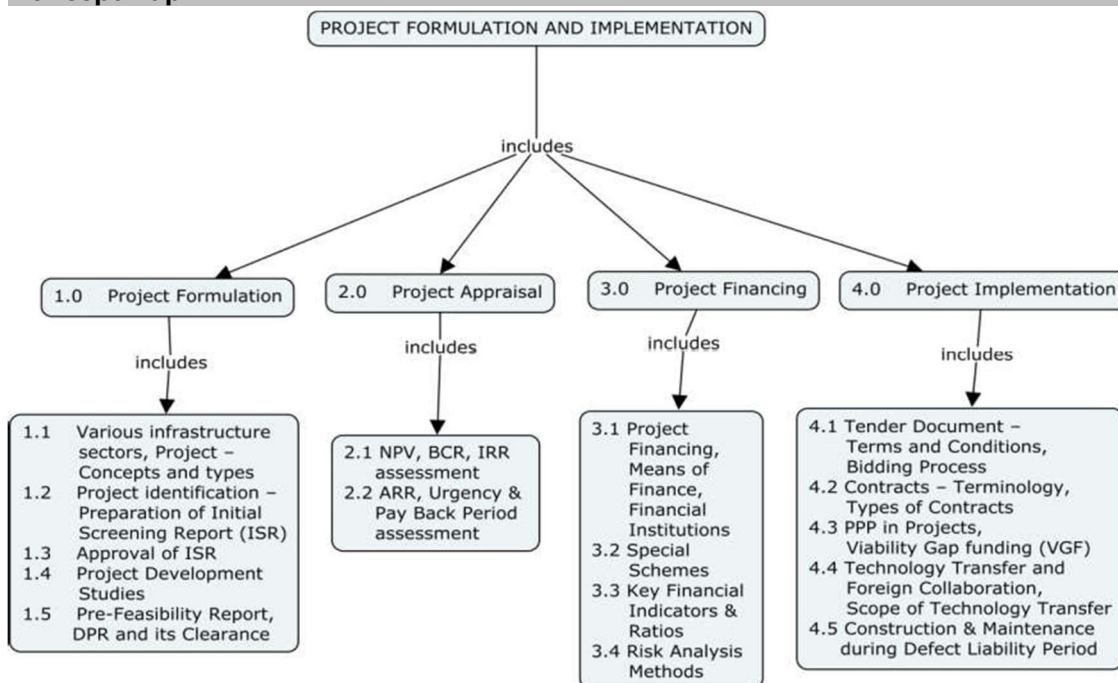
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	S	M	M	---	M	M	M	L	S	L	S	M
CO2	S	S	S	M	M	M	S	L	M	S	M	S	M
CO3	M	M	M	---	---	M	S	M	L	M	M	M	L
CO4	S	S	S	M	S	M	S	M	M	S	M	M	M
CO5	S	M	S	M	---	S	S	M	L	S	M	S	M
CO6	S	S	M	M	---	M	M	M	L	M	L	M	M
CO7	S	S	S	M	M	M	M	L	L	M	M	M	M
CO8	S	M	S	M	M	M	S	M	M	M	L	M	M
CO9	S	M	M	L	---	S	M	S	L	S	M	M	M
CO10	S	S	M	L	---	M	M	S	M	S	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern: Theory Part:

Bloom's Category	Continuous Assessment Tests		Test 3	Terminal Examination (Theory part only for 100 marks)
	1	2	Practical Examination (30 marks)	
Remember	20	10		20
Understand	40	30		40
Apply	40	60		40
Analyse	0	0		0
Evaluate	0	0		0
Create	0	0		0

Concept Map



Syllabus

Project Formulation: Introduction to various Infrastructure Sectors, Project – Concepts – Project identification – Preparation of Initial Screening Report (ISR) – Approval of ISR and Project by Government / Owner / Statutory Authorities – Project Development Studies - Preliminary Analysis, SWOT analysis, Market, Technical, Financial, Economic and Ecological - Pre-Feasibility Report and its Clearance, Project Estimates and Techno-Economic Feasibility Report, Detailed Project Report – Different Project Clearances required. **Project Performance and Appraisal:** Economic evaluation, NPV – BCR – IRR – ARR – Urgency – Pay Back Period – Assessment of various methods. **Project Financing:** Project Financing – Means of Finance – Financial Institutions – Special Schemes – Government Subsidies – Leverage – Key Financial Indicators and Ratios – Analysis of Risk – Different Methods – Selection of a Project and Risk Analysis in Practice. **Project Implementation:** Tender Document – Terms and Conditions – Bidding Process – Contracts – Terminology in Contracts – Types of Contracts –Public Private Partnership in Projects – Viability Gap funding (VGF) –Technology Transfer and Foreign Collaboration – Scope of Technology Transfer – Construction & Maintenance during Defect Liability Period.

References

1. Raina V.K, "Construction Management Practice – The inside Story", Tata McGraw Hill Publishing Limited, 2005
2. Leslie Feigenbaum, "Construction Scheduling With Primavera Project Planner", Prentice Hall, 2002
3. W.Ronald Hudson, Ralph Haas, Waheed Uddin, "Infrastructure Management: Integrating, Design, Construction, Maintenance, Rehabilitation and renovation" , McGrawHill Publisher, 2013
4. Prasanna Chandra, "Projects – Planning, Analysis, Selection, Implementation Review", Tata McGraw Hill Publishing Company Ltd., New Delhi. 2006.
5. Joy P.K., "Total Project Management - The Indian Context", Macmillan India Ltd., 1992
6. Report on Indian Urban Infrastructure and Services – The High Powered Expert Committee for estimating the Investment Requirements for Urban Infrastructure Services, March 2011
7. Urban Water Development in India 2011 – Published and Distributed by India Infrastructure Research
8. Manual on sewerage and sewage treatment, CPHEEO, ministry of urban affairs & employment, Govt.of India, New Delhi, 2012
9. Manual of National Highway Authority of India, 1988
10. International Guide for Reconstruction and Development, 1992

Course Content and Lecture Schedule (Theory Part)

Module No.	Topics	Periods
1.0	Project Formulation	
1.1	Introduction to various Infrastructure Sectors, Project – Concepts, types of projects based on nature	2
1.2	Project identification – Preparation of Initial Screening Report (ISR)	1
1.3	Approval of ISR and Project by Government / Owner / Statutory Authorities	1
1.4	Project Development Studies- Preliminary Analysis, Market, Technical, Financial, Economic and Ecological	2
1.5	Pre-Feasibility Report and its Clearance, Project Estimates and Techno-Economic Feasibility Report, Detailed Project Report – Different Project Clearances required	2
2.0	Project Appraisal	

2.1	Net Present Value, Benefit Cost Ratio & Internal Rate of Return methods of assessment	2
2.2	ARR, Urgency & Pay Back Period methods of assessment	2
3.0	Project Financing	
3.1	Project Financing, Means of Finance and Financial Institutions	1
3.2	Special Schemes, Government Subsidies- Leverage	1
3.3	Key Financial Indicators and Ratios	1
3.4	Analysis of Risk – Different Methods, Risk Analysis and Selection of a Project	2
4.0	Project Implementation	
4.1	Tender Document – Terms and Conditions, Bidding Process	2
4.2	Contracts – Terminology, Types of Contracts	1
4.3	Public Private Partnership in Projects, Viability Gap funding (VGF)	1
4.4	Technology Transfer and Foreign Collaboration, Scope of Technology Transfer, Case studies	2
4.5	Construction & Maintenance during Defect Liability Period	1
	Total Hours	24

List of Exercises for Practical Part

Module No.	Exercise No.	No. of hours
1	Selection of project and preparation of Initial Screening Report with proper justification	2
2	Preparation of prefeasibility report with required data for the chosen project	2
3	Identification of the various approval required for the chosen project with time frame and appropriate sanctioning authorities	2
4	Examine the viability of appraisal of the project by discounting method	2
5	Examine the viability of appraisal of the project by non-discounting method	2
6	Identify and manage the risk in the project by suitable methods and Prepare a suitable risk management plan for the chosen project	2
7	Identify the various sources of finance and Financial institutions to be approached for funding of the project	2
8	Identify and select suitable Governmental/ Non-Governmental schemes for the selected project. Draft the benefits to the project through the schemes	2
9	Preparation of tender document and tender notice for the project	2
10	Preparation of contract document for the project	2
11	Identify and document issues likely to appear during Defect Liability period for the project	2
12	Preparation of Detailed Project Report for a given project	2
	Total Hours	24

Course Designers:

- | | |
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18IM170**TRAFFIC ENGINEERING LAB**

Category L T P Credit

PC 0 0 4 2

Preamble

The objective of this laboratory course is to impart knowledge on traffic volume count studies, speed and delay studies, origin and destination study, accident analysis and parking studies. Students will be acquiring knowledge on pedestrian facilities, road safety audit and technical report writing.

Prerequisite

Knowledge in traffic engineering

Course Outcomes

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

COs	Description	Blooms Levels	Expected Proficiency Level	Expected Attainment Level
CO1	Conduct traffic volume count study	Analyze	80	A
CO2	Conduct test on spot speed and interpret the results	Analyze	80	A
CO3	Perform on-street and off-street parking studies and analyze the collected data	Analyze	80	A
CO4	Determine journey speed, running speed and delay on the given route	Apply	80	A
CO5	Perform OD survey for demand assessment	Apply	80	A
CO6	Analyze crash data and recommend suitable measures	Analyze	80	A
CO7	Conduct road safety audit	Apply	80	A
CO8	Prepare questionnaire and perform household survey for data analysis for given project	Analyze	80	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	M	M	---	---	M	M	---	M	M	M	M	M
CO2	S	S	M	---	---	S	M	---	M	M	M	M	M
CO3	S	S	S	S	---	M	S	---	M	M	M	M	M
CO4	S	M	M	---	L	M	---	---	M	M	M	M	M
CO5	S	S	M	---	---	M	S	S	M	M	M	M	M
CO6	S	S	S	S	---	M	---	S	---	M	M	M	M
CO7	S	S	M	M	M	M	M	---	---	M	M	M	M
CO8	S	S	S	S	S	M	---	---	---	M	M	M	M

S- Strong; M-Medium; L-Low

List of Experiments

1. a. Conduct the classified volume count on link roads.
b. Analyze the classified volume count data on link roads.
2. a. Conduct turning movement and classified volume count study on the Intersection.
b. Analyze the turning movement and classified volume count data on the Intersection.
3. a. Perform Spot speed study of classified vehicle.
b. Analyze the Spot speed data of classified vehicle and interpret the results with codal provisions.
4. a. Conduct speed flow studies.
b. Analysis the speed flow data for determination of speed portfolios.
5. a. Conduct Speed and Delay study on the given route by Moving Car Observer Method.
b. Analyze the Speed and Delay data on the given route.
6. a. Perform on-street parking survey using cardon count method.
b. Analyze the on-street parking data using cardon count method.
7. a. Perform off-street parking survey.
b. Analyze the off-street parking data.
8. a. Perform Origin – Destination survey for traffic demand assessment by registration Number method.
b. Analyze the Origin – Destination survey data for traffic demand assessment.
9. a. Collect the accident records for past years on the road stretch.
b. Analyze the accident records for past years on the road stretch and identify Suitable measures for black spots.
10. a. Collection of data on road safety audit for the given link road.
b. Analysis of data on road safety audit for the given link road and prepare technical Audit report.
11. a. Conduct Pedestrian survey.
b. Analyze the data for pedestrian survey.
12. a. Prepare questionnaire and perform household survey.
b. Analyze the data for performed household survey.

References

1. Kadiyali L.R, "Traffic Engineering and Transportation Planning" Khanna Publishers, Delhi, 2005.
2. Taylor M.A.P and Young W, Traffic Analysis-New Technology and New solutions, Hargreen Publishing Company, 1998.
3. Partha Chakroborty and Animesh Das, "Principle of Traffic Engineering", Prentice Hall of India, New Delhi, 2003.
4. Mike Slinn, Peter Guest and Paul Matthews "Traffic Engineering Design Principles and Practice", Elsevier, 2006.
5. IRC SP 019: Manual for Survey, Investigation and Preparation of Road Projects, 2001
6. IRC 103 Guidelines for Pedestrian Facilities
7. <http://www.nptel.ac.in/downloads/105101008/>
8. <http://www.nptel.ac.in/downloads/105101008/>

Course Designers:

- | | |
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18IM260

PROJECT PLANNING AND CONTROL

Category	L	T	P	Credit
PC	2	2	0	3

Preamble

Complex infrastructure projects can be managed effectively if the project managers have the means to plan and control the schedules and costs of the work required to achieve their technical performance objectives. While planning projects aspects such as resources needed for its accomplishment, its costs and duration are to be determined. These can be found by adopting the modern techniques of project management. This theory cum practical course is designed to give an exposure on planning, scheduling and control of projects using application of network techniques.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Bloom's Level	Expected Attainment level (%)	Expected Proficiency (grade)
(CO1)	Explain the concept of projects, its process, objectives and functions of project management	Understand	75	A
(CO2)	Develop a network diagram for a project from activity relationships	Apply	75	A
(CO3)	Analyze and update projects using Critical Path Method (CPM) and Programme Evaluation and Review Technique (PERT)	Apply	80	A
(CO4)	Balance resource requirements of projects to avoid idling	Analyze	75	A
(CO5)	Crash projects. Conduct Earned Value Analysis (EVA) for the project	Analyze	75	B

COs for Practical part:

COs	Course Outcome Detail (COs)	Bloom's Level	Expected Attainment level (%)	Expected Proficiency (grade)
(CO6)	Create a Work Break Down Structure (WBS) for a project and analyze using Gantt Chart / Bar chart	Understand	75	A
(CO7)	Prepare WBS, Analyze and Managetime in projects through Gantt charts. Develop network for a project	Apply	80	A
(CO8)	Analyze and update project with CPM using Primavera software	Apply	80	A
(CO9)	Balance resource of projects using Primavera software	Analyze	75	A
(CO10)	Crash projects and conduct EVA using Primavera software	Analyze	75	B
(CO11)	Analyze project using PERT	Apply	75	A

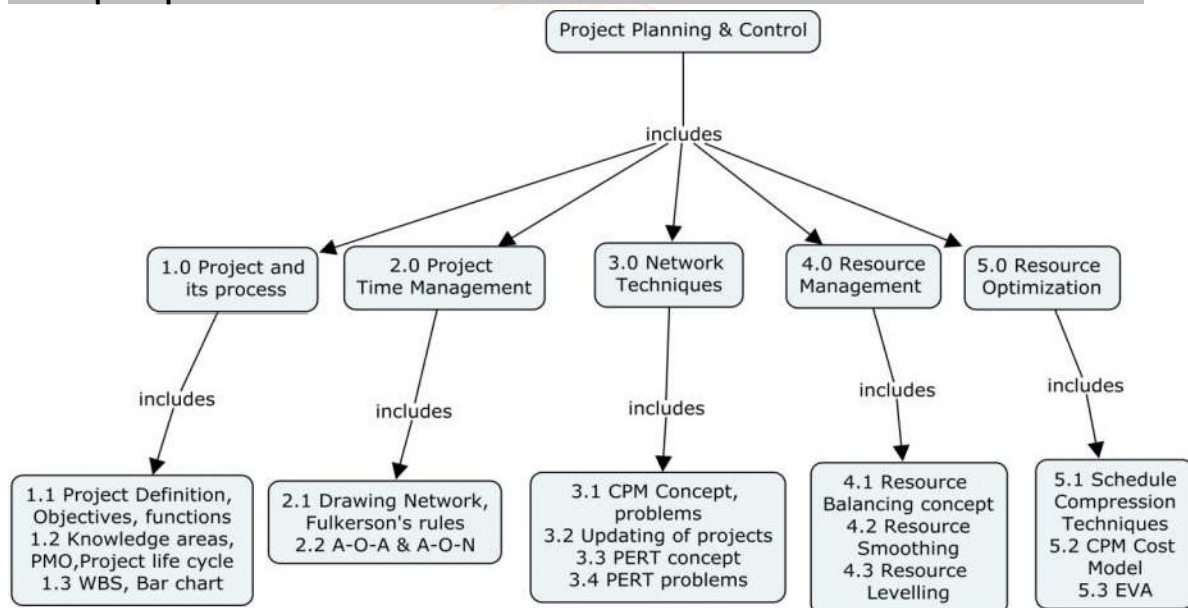
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	---	---	---	---	---	L	L	---	L	L	L	L
CO2	S	S	S	L	L	S	M	M	M	L	M	S	M
CO3	S	S	S	L	L	M	S	M	M	L	M	S	M
CO4	S	S	S	L	L	M	S	M	L	L	M	S	L
CO5	S	S	S	L	L	L	S	M	L	L	M	S	S
CO6	S	S	S	M	S	L	M	L	M	---	S	M	L
CO7	S	S	S	M	S	L	M	L	M	---	S	M	L
CO8	S	S	S	M	S	L	M	L	M	---	S	M	L
CO9	S	S	S	M	S	L	M	L	M	---	S	M	L
CO10	S	S	S	M	S	L	S	L	M	---	S	M	L
CO11	S	S	S	M	S	L	M	L	M	---	S	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern : Theory and Practical Parts

Bloom's Category	Continuous Assessment Tests		Test 3	Terminal Examination (Theory part only for 100 marks)
	1	2		
Remember	10	10	Practical Examination (30 marks)	10
Understand	10	10		10
Apply	60	60		60
Analyse	20	20		20
Evaluate	0	0		0
Create	0	0		0

Concept Map**Syllabus**

Project and its process - Definition of project, Objectives and functions of Project management, characteristics and types of projects. Project Time Management: Project Scope Management - Work break down structure- Activity/ Task- Events- Case study. Project planning tools- Rolling wave planning. Gantt Charts, Milestone chart, Program

Progress chart. Project Network- Fulkerson's rules – A-O-A and A-O-N networks. Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- 80-20 rule- Case study, type of time estimates & Square network diagram. Project updating and monitoring- Case study. Estimate time- Program Evaluation & Review Technique (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources. Resource Management: Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- Resource Smoothing technique- Time constraint. Resource leveling technique- Resource constraint- Case study. Resource optimization: Types of cost – Direct, Indirect and Total Cost. Variation of Cost with time. Schedule Compression Techniques- Crashing, Fast Tracking & Re-estimation- Crash time and crash cost. Optimize project cost for time and resource. CPM Cost model.

References

1. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT/CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1994.
2. Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 2016
3. Srinath L.S., "PERT & CPM- Principles and Applications", Affiliated East West Press Pvt., Ltd., New Delhi, 2008
4. Sengupta. B and Guha. H, "Construction Management and Planning", Tata McGraw Hill, New Delhi, 1995
5. SangaReddi. S and Meiyappan. PL, "Construction Management", Kumaran Publications, Coimbatore, 1999

Course Contents and Lecture Schedule (Theory Part)

Module No.	Topic	No. of Lectures
1.0	Project and its process	
1.1	Definition of projects and process, boundaries of project Introduction to project management concept, background of management, purpose, objectives, Characteristics of projects and Functions of management	1
1.2	Roles of project management group, project management office and its role, Project knowledge area, project integration- process group interaction, Project flow, project life cycle- influencing factors, Case study	1
1.3	Project - Work break down structure. Traditional management systems – Gantt approach, progress- chart, Bar-chart- Merits and limitations	2
2.0	Project Time Management	
2.1	Introduction to network concepts, network elements and inter-relationships. Development of network based on Fulkerson's rules- Problems in development of network	1
2.2	Drawing of Networks for project – A-O-A and A-O-N methods	2
3.0	Network Techniques	
3.1	Critical Path Method (CPM) for management, CPM network analysis. Identification of critical path, floats, square network diagrams- problems	2
3.2	Reviewing, updating and monitoring – concept. Problems	2
3.3	Programme Evaluation and Review Technique (PERT) network- introduction to theory of probability and statistics, probabilistic time estimation for activities	1
3.4	Analysis by PERT – problems	2
4.0	Resource Management	
4.1	Resource balancing- objectives, resource smoothing technique – concept and procedure	1
4.2	Problems using resource smoothing technique	2

4.3	Resource Levelling technique - concept and procedure, problems	2
5.0	Resource Optimization	
5.1	Introduction to two-dimensional network analysis – activity cost information, cost –time relationship	1
5.2	Project direct, indirect and total cost. Crashed programmes, network compression, least cost solution, least time solution and optimum time solution-Problems	2
5.3	Earned Value Analysis for project	2
	Total Periods	24

List of Exercises for Practical Part

Ex. No.	Title	No. of practical hours
1.	Creating a Work Break Down Structure (WBS) for a project	2
2.	Analysis of projects using Gantt Chart / Bar chart	2
3.	Developing network diagram for a project from activity relationships using Primavera software	2
4.	Analyze and update project with CPM using Primavera software	3
5.	Balance resource of projects using Primavera software - resource smoothing technique	3
6.	Balance resource of projects using Primavera software- resource levelling technique	3
7.	Crash projects to determine minimum direct cost using Primavera software	3
8.	Crash projects to determine optimum time – minimum total cost using Primavera software	2
9.	Conduct Earned Value Analysis for the project	2
10.	Conduct PERT analysis on the given project	2
	Total Hours	24

Course Designers:

Dr. G.Chitra

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18IM270

**BUILDING INFORMATION
MODELING LAB**Category L T P Credit
PC 0 0 4 2**Preamble**

The course is concerned specifically with the utilization of Building Information Modeling (BIM) technology. The aim of the course is to give students a practical, hands-on introduction to BIM and related computer-based techniques for the documentation and modeling of designed structures. The course will be focusing on the processes involved in developing a full 3D design object model, not for the purpose of visualization alone, but more importantly as a tool for understanding and documenting how a proposed building design fits together and how it will perform during use. The course will introduce students to innovative concepts and processes of Building Information Modeling (BIM), a wide range of BIM applications used in the architecture, engineering and construction (AEC) industry, and future trends of BIM developments.

Students will learn how to efficiently implement BIM to develop, coordinate and communicate design intent as well as to convey data necessary for further building analysis such as materials take off, MEP, and structures.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will:

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency Level (Grade)
CO1	Understand concepts of Building Information Modeling (BIM)	Understand	80	A
CO2	Review software and technology available for BIM	Apply	80	A
CO3	Use BIM software create a model of a building	Apply	80	A
CO4	Use BIM to check for interferences and conflicts on a building construction project	Apply	80	A
CO5	Explore construction scheduling and sequencing using BIM	Apply	80	A
CO6	Explore cost estimating using BIM	Apply	80	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO5	S	S	M	---	S	S	S	---	L	---	---	M	L
CO6	S	S	M	---	S	S	S	---	L	---	---	M	L
CO3	S	S	M	---	S	S	S	---	S	---	L	S	S
CO4	S	S	M	---	S	S	S	---	S	---	L	S	S
CO5	S	S	M	---	S	S	S	---	S	---	L	S	S
CO6	S	S	M	---	S	S	S	---	S	---	L	S	S

S- Strong; M-Medium; L-Low

List of Experiments

1. Introduction to Building Information Modeling (BIM), Definition, From CAD to BIM.
2. Level of Detail (LOD) in BIM, Necessities of BIM, Benefits of BIM.
3. Discussion of the role of BIM in the Construction Engineering and Management; Revit Architecture.
4. View & Retrieve Information from BIM Models : View controls - pan, zoom, rotate, and arrange views, Visibility of elements, Section a 3D view, Retrieve information from schedules, Measure distance in BIM models.
5. Creating sets, building elements. Modeling Building Elements: modeling exterior and interior walls, creating floors and roofs, Adding doors, windows, footings, columns, and beams.
6. Usage of tools: Grid, Level, Topo-surface, Column, Beam, Floor.
7. Usage of tools: Wall, Door, Window. Working with doors, windows, and wall openings, creating roofs with different shapes and slopes.
8. Usage of tools: Interiors and Circulation: Creating stairs and ramps, customizing stair shapes, modeling elevators.
9. Visualization and Rendering.
10. BIM and Construction Cost Estimating and Scheduling

References

1. Eastman, C, Teicholz, P, Sacks, R and Liston, K. 2008, BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors, Australia published in the United States as Hoboken, N. J, 2008, Wiley)
2. Hardin, B., & McCool, D. (2016). BIM and construction management: proven tools, methods, and workflows. John Wiley & Sons
3. Building Information Modeling (BIM): A framework for Structural Design, by Nawari & Kuenstle, CRC press ISBN-13: 978-1482240436, ISBN-10: 1482240432, CRC Press, Taylor and Francis Group. <http://www.crcpress.com/>; spring 2015. By N. Nawari & M. Kuenstle.
4. Fundamentals of Building Construction, by Allen, Edward, Wiley.
5. Instructors' Lecture Materials, Notes and Handouts.
6. <http://wikihelp.autodesk.com/Revit/enu/20127>
7. <http://www.revitcity.com>

Course Designers:

- | | |
|------------------|----------------------------------------------------|
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| 2. Mr. R. Jegan | rjnciv@tce.edu |

18IMPA0 CONTRACTS AND ARBITRATION

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course will create awareness on contracts for construction industry, impart knowledge on tender preparation, tendering process, laws on arbitration, arbitration procedure and laws on dispute resolution in India.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Bloom's Level	Expected Attainment Level (%)	Expected Proficiency Level(grade)
CO1:	Understand the various clauses of construction contracts with their legal aspects and its provisions	Understand	75	A
CO2:	Apply knowledge on different types of contracts for selecting suitable type of contracts in construction projects	Apply	75	B
CO3:	Apply knowledge of contracts in preparation of contract document and tendering process	Apply	75	B
CO4:	Explain the need, importance of labour regulations for construction industry	Apply	75	A
CO5:	Suggest suitable type of dispute resolution for the given situation of problem	Apply	75	B

Mapping with Programme Outcomes

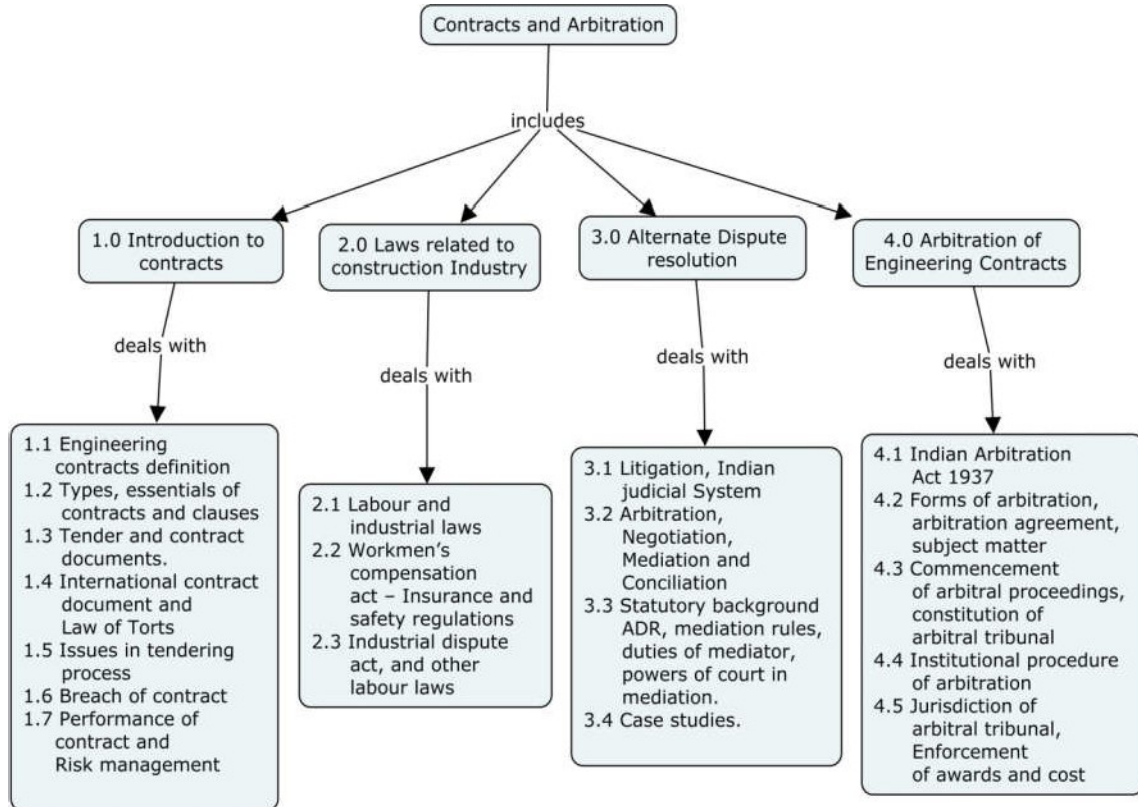
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	M	L	M	---	---	---	M	M	M	L	M	M
CO2	S	M	M	L	---	L	M	M	M	M	L	S	M
CO3	S	S	S	M	---	M	M	S	M	S	M	S	M
CO4	S	M	M	L	---	L	M	S	M	M	M	S	M
CO5	S	S	S	L	---	M	L	S	M	S	L	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	20	30	30	30
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Introduction to contracts in construction industry: Brief details of Engineering contracts – definition, types and essentials of contracts and clauses for contracts – Preparation of tender documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view and standard contract documents – International contract document, World bank procedures and guidelines, Law of Torts – Issues related to tendering process- Awarding contract, e-tendering process. Time of performance – provisions of contract law – Breach of contract. Performance of Contracts – Discharge of a contract- Indian Contract Act 1872 – Risk management in contracts. **Laws related to Construction Industry** – Labour and industrial laws - payment of wages act, contract labour – Workmen’s compensation act – Insurance and safety regulations, Industrial dispute act, Indian factory act, Child labour act and other labour laws. **Alternate Dispute resolution** – Litigation in Indian courts, Dispute resolution mechanism under the Indian judicial System Arbitration, Negotiation, Mediation and Conciliation – concepts and purpose, Statutory back ground ADR and mediation rules, duties of mediator and disclose facts, power of court in mediation, Case studies. **Arbitration of Engineering Contracts** – Background of Arbitration in India, Indian Arbitration Act 1937, UNCITRAL model law, Forms of arbitration – arbitration agreement, subject matter and violations, Commencement of arbitral proceedings, constitution of arbitral tribunal, appointment of arbitrator and rules of evidence, Institutional procedure of arbitration, Independence of arbitrators jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards and cost.

References

1. American Arbitration Association, “Construction industry arbitration rules and mediation procedures”, 2007
2. Case study of Southern Railway Arbitration Cases-
wiki.iricen.gov.in/doku/lib/exe/fetch.php

3. Collex.K, "Managing Construction Contracts", Reston publishing company, Virginia, 1982
4. Eastern Book Company "Arbitration and Conciliation Act 1996", June 2008
5. International Federation of Consulting Engineers (FIDIC) documents, Geneva, 2009 (<http://www.fidic.org>)
6. Gajaria. G.T, " Laws relating to building and Engineer's Contracts", M.M. Tripathi Pvt Ltd., Mumbai, 1985

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Introduction to contracts	
1.1	Brief details of Engineering contracts	1
1.2	Types, essentials of contracts and clauses of contract	1
1.3	Preparation of tender documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view and standard contract documents.	2
1.4	International contract document, World bank procedures and guidelines, Law of Torts	2
1.5	Issues related to tendering process- Awarding contract, e-tendering process	2
1.6	Time of performance – provisions of contract law – Breach of contract	2
1.7	Performance of Contracts – Discharge of a contract – Indian Contract Act 1872, Risk management in contracts.	3
2.0	Laws related to Construction Industry	
2.1	Labour and industrial laws - payment of wages act, contract labour.	2
2.2	Workmen's compensation act – Insurance and safety regulations	2
2.3	Industrial dispute act, Indian factory act, Child labour act and other labour laws	1
3.0	Alternate Dispute resolution	
3.1	Litigation in Indian courts, Dispute resolution mechanism under the Indian judicial System	2
3.2	Arbitration, Negotiation, Mediation and Conciliation – concepts and purpose	3
3.3	Statutory back ground ADR and mediation rules, duties of mediator and disclose facts, power of court in mediation.	2
3.4	Case studies.	3
4.0	Arbitration of Engineering Contracts	
4.1	Background of Arbitration in India, Indian Arbitration Act 1937, UNCITRAL model law,	2
4.2	Forms of arbitration – arbitration agreement, subject matter and violations	1
4.3	Commencement of arbitral proceedings, constitution of arbitral tribunal, appointment of arbitrator and rules of evidence	2
4.4	Institutional procedure of arbitration	2
4.5	Independence of arbitrators jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards and cost.	1
	TOTAL	36

Course Designers:

- | | |
|-------------------------|-----------------|
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18IMPB0**STRATEGIC PLANNING FOR
INFRASTRUCTURE SECTORS**Category L T P Credit
PE 3 0 0 3**Preamble**

This course gives an exposure to the students on the concepts and principles of planning and management applied to infrastructure sectors.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will:

COs	Description	Blooms Level	Expected Attainment Level (%)	Expected Proficiency Level (Grade)
CO1	Illustrate the techno-managerial aspects related to infrastructure sectors and infrastructure projects.	Apply	80	A
CO2	Assess the merits and demerits of infrastructure privatization.	Apply	80	A
CO3	List the challenges and suggest solutions in infrastructure planning and implementation.	Apply	80	A
CO4	Apply strategies for successful implementation of infrastructure projects.	Apply	80	A
CO5	Assess an infrastructure project by performing economic and financial analysis	Analyse	80	A

Mapping with Programme Outcomes

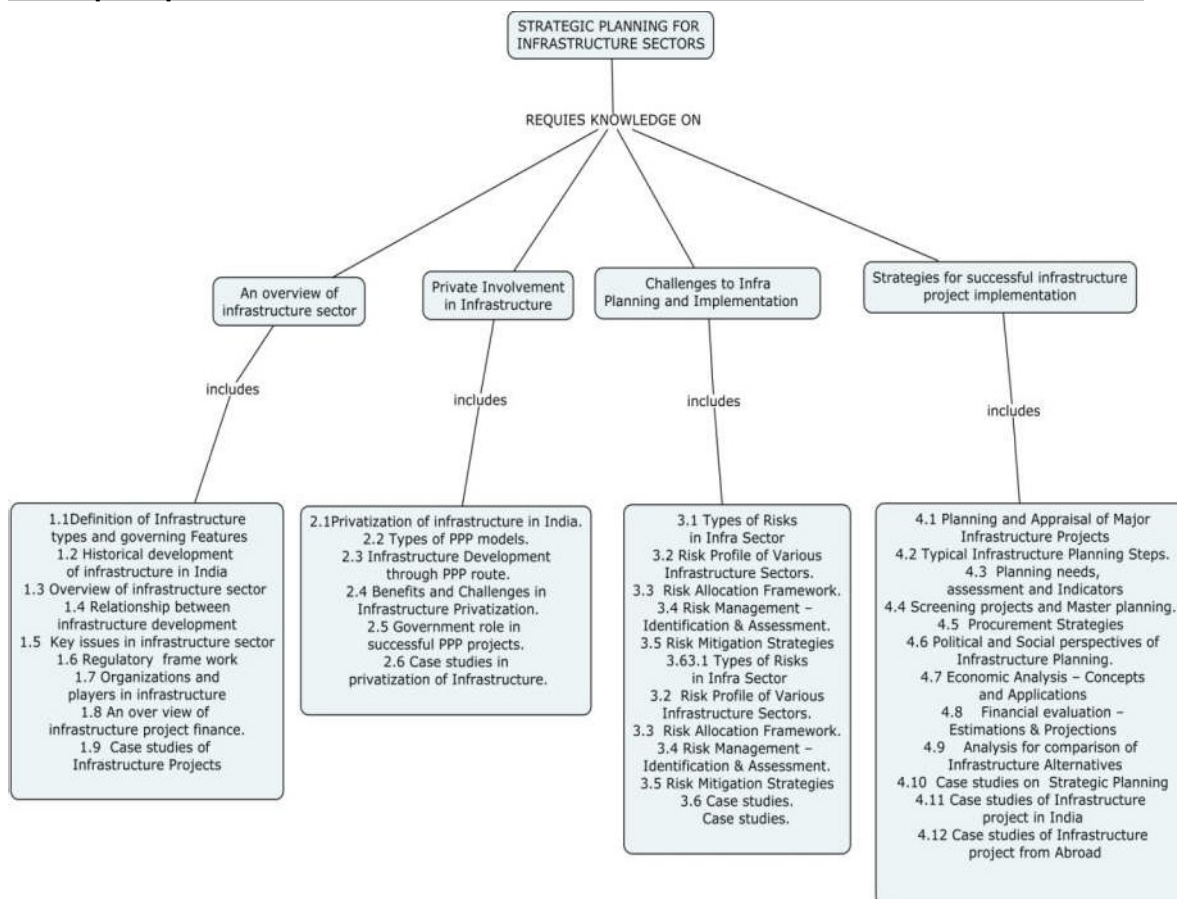
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	M	L	--	M	--	S	L	--	--	M	M	L
CO2	S	S	S	--	--	--	M	L	--	--	--	M	L
CO3	S	M	S	--	M	L	L	--	L	--	M	M	M
CO4	S	M	S	L	M	L	L	--	L	L	--	S	M
CO5	S	M	S	L	M	L	M	L	L	L	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

An overview of infrastructure sector: Definition of Infrastructure types and governing Features - Historical development of infrastructure in India - Overview of infrastructure sector - Relationship between infrastructure development - Key issues in infrastructure sector - Regulatory frame work - Organizations and players in infrastructure - An over view of infrastructure project finance - Case studies of Infrastructure Projects

Private Involvement in Infrastructure: Privatization of infrastructure in India -Types of PPP models - Infrastructure Development through PPP route - Benefits and Challenges in Infrastructure Privatization - Government role in successful PPP projects - Case studies in privatization of Infrastructure

Challenges to Infra Planning and Implementation :Types of Risks in Infra Sector - Risk Profile of Various Infrastructure Sectors - Risk Allocation Framework - Risk Management – Identification & Assessment - Risk Mitigation Strategies - Case studies.

Strategies for Successful Infrastructure Project Implementation :Planning and Appraisal of Major Infrastructure Projects - Typical infrastructural planning steps - Screening projects and Master planning - Political and Social perspectives of Infrastructure Planning - Economic Analysis – Concepts and Applications - Financial evaluation – Estimations & Projections - Case studies on Strategic Planning - Analysis for comparison of Infrastructure Alternatives- Procurement Strategies - Case studies of Infrastructure project in India - Case studies of Infrastructure project from Abroad

References

1. A.S. Godman and Hastak, "Infrastructure planning handbook: planning, engineering and economics", McGraw Hill, New York, 2006.
2. J. Parkin and D. Sharma, "Infrastructure planning", Thomas Telford, London 1999.
3. David I. Cleland and Roland Gareis, "Global Project Management Handbook: Planning, Organization and Controlling International Projects", 2nd edition, McGraw Hill Series, 2006
4. Richard Lambeck, John Eschemuller, "Urban Construction Project Management", McGraw Hill Series, 2009
5. NITI Aayog Document.
6. VISION –TAMILNADU 2023-Strategic plan for Infrastructure Development in Tamilnadu.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	An overview of Infrastructure sector	
1.1	Definition of Infrastructure types and governing Features	1
1.2	Historical development of infrastructure in India	1
1.3	Overview of infrastructure sectors	1
1.4	Relationship between infrastructure and Development	1
1.5	Key issues in infrastructure sector	1
1.6	Regulatory frame work	1
1.7	Organizations and players in infrastructure	1
1.8	An over view of infrastructure project finance.	1
1.9	Case studies on Infrastructure sector wise Projects.	1
2.0	Private Involvement in Infrastructure	
2.1	Privatization of infrastructure in India.	1
2.2	Types of PPP models.	1
2.3	Infrastructure Development through PPP route.	1
2.4	Benefits and Challenges in Infrastructure Privatization.	1
2.5	Government role in successful PPP projects.	1
2.6	Case studies on privatization of Infrastructure.	1
3.0	Challenges to Infra Planning and Implementation	
3.1	Types of Risks in Infra Sector	1
3.2	Risk Profile of Various Infrastructure Sectors.	1
3.3	Risk Allocation Framework.	1
3.4	Risk Management – Identification & Assessment.	1
3.5	Risk Mitigation Strategies	1
3.6	Case studies on risk allocation.	1
4.0	Strategies for successful infrastructure project implementation	
4.1	Planning and Appraisal of Major Infrastructure Projects	1
4.2	Typical Infrastructure Planning Steps.	1
4.3	Planning needs, assessment and Indicators	1
4.4	Screening projects and Master planning.	1
4.5	Procurement Strategies	1
4.6	Political and Social perspectives of Infrastructure Planning.	1

4.7	Economic Analysis – Concepts and Applications	1
4.8	Financial evaluation – Estimations & Projections	1
4.9	Analysis for comparison of Infrastructure Alternatives	1
4.10	Case studies on Strategic Planning	2
4.11	Case studies of Infrastructure project in India	2
4.12	Case studies of Infrastructure project from Abroad	2
Total Periods		36

Course Designer:

- | | | |
|----|-------------------|-------------------------|
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18IMPCO	MANAGEMENT OF HUMAN RESOURCES, SAFETY AND QUALITY	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To impart knowledge on management of human resources, labour legislation, safety and quality aspects in construction

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs	Description	Bloom's Level	Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Identify the need and importance of human resource management	Understand	75	A
CO2	Adapt the labour laws comply with construction industry in the projects	Apply	75	A
CO3	Identify the need and measures to improve safety in construction industry and safety audit	Apply	75	A
CO4	Identify the need for applying ergonomics to construction industry	Apply	75	A
CO5	Enumerate the need, importance, elements of quality and significance of quality assurance in industry	Apply	75	A

Mapping with Programme Outcomes

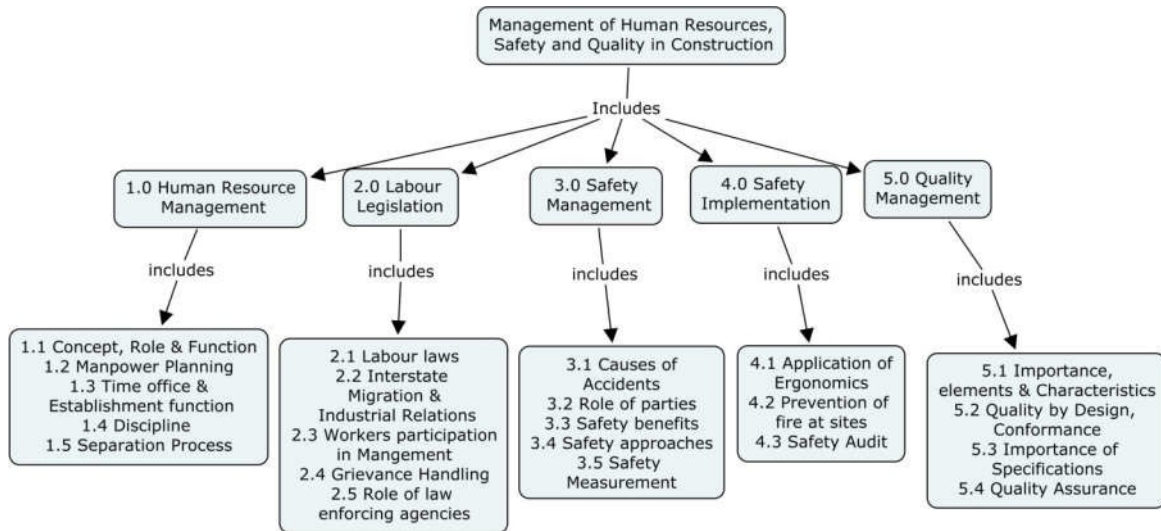
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	M	L	M	---	---	---	M	M	M	L	M	S
CO2	S	M	M	L	---	L	M	M	M	M	L	M	M
CO3.	S	S	S	M	---	M	M	S	M	S	M	M	M
CO4.	S	M	M	L	---	L	M	S	M	M	M	S	S
CO5.	S	S	S	L	---	M	L	S	M	S	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	20	30	30	30
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Human Resources Management- Introduction – Concept- Growth – Role and function. Manpower Planning for Construction Companies – Line and Staff function. Recruitment, selection, placement, induction and training; over staffing; Time office and establishment functions; wage and salary administration – Discipline- Separation Process. **Labour Legislation-** Labour laws- labour law relating to construction industry- Interstate migration- Industrial relations- Collective bargaining- Worker’s participation in management. Grievance handling- discipline-role of law enforcing agencies and judiciary – women in construction industry. **Safety Management-** importance of safety- causes of accidents – responsibility for safety –Role of various parties in safety management – safety benefits- approaches to improve safety in construction for different works- measuring safety. **Safety Implementation** - Application of Ergonomics to the construction industry- prevention of fires at construction site- Safety audit. **Quality Management in Construction-** Importance of quality; Elements of quality- quality characteristics- quality by design - quality conformance, contractor quality control- identification and traceability, Continuous Chain Management – brief concept and application. Importance of specifications- Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection. Quality assurance techniques – Inspection, testing, sampling. Documentation – Organization for quality control, Cost of quality. Introduction to TQM, Six Sigma Concept

Reference Books

1. Arya Ashok “Discipline & Disciplinary procedure” Organisation Development Institute, 1998
2. Arya Ashok, “Management case studies – An analytical and Developmental Tool” Organisation Development Institute, New Delhi, 1999
3. Grant E.L., and Leavens worth, “Statistical Quality Control”, Mc Graw Hill, 1984.
4. Josy J. Farrilaro, “Hand Book of Human Resources Administration” Mc.Graw Hill (International Edition)1987.
5. Malik, P.L., “Handbook of Labour & Industrial Law”, Eastern book company, Lalbagh, Lucknow, 2010
6. Manoria C.B., “Personnel Management”, Himalaya Publishing House, 1992.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Human Resources Management	
1.1	Introduction – Concept- Growth – Role and function	1
1.2	Manpower Planning for Construction Companies– Line and Staff function. Recruitment, selection, placement, induction and training; over staffing	1
1.3	Time office and establishment functions; wage and salary administration	1
1.4	HRM – Discipline	1
1.5	HRM - Separation Process	2
2.0	Labour Legislation	
2.1	Labour laws- labour law relating to construction industry	3
2.2	Interstate migration- Industrial relations -Collective bargaining	1
2.3	Worker's participation in management	1
2.4	Grievance handling – discipline	1
2.5	Role of law enforcing agencies and judiciary – women in construction industry	1
3.0	Safety Management	
3.1	Importance of safety- causes of accidents – responsibility for safety	2
3.2	Role of various parties in safety management	2
3.3	Safety benefits	1
3.4	Approaches to improve safety in construction for different works	2
3.5	Safety Measurement, Safety standards	2
4.0	Safety Implementation	
4.1	Application of Ergonomics to the construction industry	2
4.2	Prevention of fires at construction site, Site safety planning	2
4.3	Safety audit	1
5.0	Quality Management in Construction	
5.1	Importance of quality; Elements of quality- quality characteristics, Quality control in construction- identification and traceability, Continuous Chain Management – brief concept and application	3
5.2	Quality by design- quality conformance, contractor quality control	2
5.3	Importance of specifications- Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection	2
5.4	Quality assurance techniques – Inspection, testing, sampling Documentation – Organization for quality control, Cost of quality, Introduction to TQM, Six Sigma Concept	2
	Total Periods	36

Course Designers:

- | | | |
|----|-----------------|---------------|
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18IMPD0**CONSTRUCTION EQUIPMENT
MANAGEMENT**Category L T P Credit
PE 2 1 0 3**Preamble**

Selection of appropriate equipment based on the requirements of project is crucial for completion of project at optimal cost and time. The mistakes during selection of equipment for any construction can be avoided by scheduling and optimising the construction equipment system productivity and making proper equipment financing decisions. This can be accomplished by understanding cost and life of equipment and its maintenance.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Bloom's Level	Expected Attainment level (%)	Expected Proficiency (grade)
CO1	Explain the significance of equipment management and Choose an appropriate equipment for a specific purpose	Apply	80	A
CO2	Estimate various cost components of equipment	Apply	80	A
CO3	Compare and contrast various financing decisions for equipment purchase, operation and Maintenance in relation to its life cycle.	Apply	80	A
CO4	Estimate & Optimize equipment system productivity	Analyze	80	A
CO5	Demonstrate how to convert a linear schedule into a precedence diagram to achieve target production rates	Analyze	80	A
CO6	Understand effective construction equipment maintenance & lower the cost of operating the equipment contemplated in the estimate.	Apply	80	A

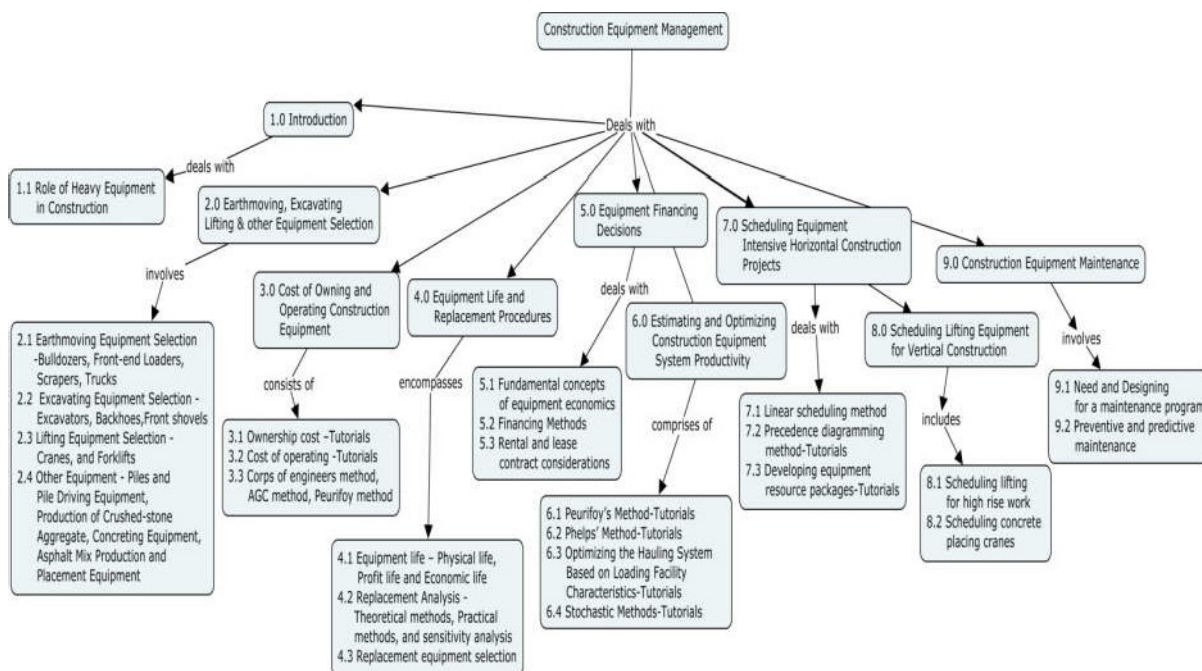
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	M	M	L	---	M	S	M	S	S	S	S	S
CO2	S	M	S	L	---	S	S	M	M	S	S	S	M
CO3.	S	S	S	M	---	S	S	S	S	S	S	S	S
CO4.	S	S	S	S	---	L	M	L	S	S	S	S	M
CO5.	S	M	M	L	---	L	L	L	M	L	L	M	M
CO6.	S	M	M	M	---	M	L	M	S	L	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	20	20
Apply	40	50	40	40
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map**Syllabus**

Role of Heavy Equipment in Construction; Earthmoving, Excavating Lifting and other Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment; Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; **Cost of Owning and Operating Construction Equipment** - Ownership cost, Depreciation, Operating cost, and Ownership and operating costs calculation methods; **Equipment Life and Replacement Procedures** - Physical, profit and economic life, Replacement analysis and selection; **Equipment Financing Decisions** - Fundamental Concepts of Equipment economics - Financing methods, Rental and lease contract considerations, **Estimating and Optimizing Construction Equipment System Productivity** - Peurifoy's method of optimizing productivity, Phelps' Method, Optimizing hauling system based on loading facility, Stochastic methods for estimation; **Scheduling Equipment Intensive Horizontal Construction Projects** - Linear scheduling method, Precedence diagramming method, Developing equipment resource packages; **Scheduling Lifting Equipment for Vertical Construction; Construction Equipment Maintenance.**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	Introduction	
1.1	Role of Heavy Equipment in Construction	1
2	Earthmoving, Excavating Lifting and other Equipment Selection	
2.1	Earthmoving Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks	1
2.2	Excavating Equipment Selection - Excavators, Backhoes, Front shovels	1
2.3	Lifting Equipment Selection - Cranes, and Forklifts	1
2.4	Other Equipment - Piles and Pile Driving Equipment, Production of Crushed-stone Aggregate, Concreting Equipment, Asphalt Mix Production and Placement Equipment	1
3	Cost of Owning and Operating Construction Equipment	
3.1	Ownership cost – depreciation cost-Tutorials	2
3.2	Cost of operating construction equipment-Tutorials	2
3.3	Methods of calculating ownership and operation cost – Corps of engineers method, AGC method, Peurifoy method	1
4	Equipment Life and Replacement Procedures	
4.1	Equipment life – Physical life, Profit life and Economic life	1
4.2	Replacement Analysis - Theoretical methods, Practical methods, and sensitivity analysis	1
4.3	Replacement equipment selection	2
5	Equipment Financing Decisions	
5.1	Fundamental concepts of equipment economics	1
5.2	Financing Methods	2
5.3	Rental and lease contract considerations	1
6	Estimating and Optimizing Construction Equipment System Productivity	
6.1	Peurifoy's Method-Tutorials	2
6.2	Phelps' Method-Tutorials	2
6.3	Optimizing the Hauling System Based on Loading Facility Characteristics-Tutorials	2
6.4	Stochastic Methods-Tutorials	3
7	Scheduling Equipment Intensive Horizontal Construction Projects	
7.1	Linear scheduling method	1
7.2	Precedence diagramming method-Tutorials	2
7.3	Developing equipment resource packages-Tutorials	2
8	Scheduling Lifting Equipment for Vertical Construction	
8.1	Scheduling lifting for high rise work	1
8.2	Scheduling concrete placing cranes	1
9	Construction Equipment Maintenance	
9.1	Need and Designing for a maintenance program	1
9.2	Preventive and predictive maintenance	1
Total Hours		36

References

- Gransberg, D.G., Popescu, C. M., and Ryan, R. C., "Construction equipment management for engineers, estimators, and owners", Taylor & Francis, New York, 2006.
- Peurifoy, R. L., Schexnayder, C. J., Shapira, A., and Schmitt, R., "Construction planning, equipment, and methods", 8th ed., McGraw Hill, New York, 2010.

3. Singh, J., "Heavy construction - planning, equipment and methods", 3rd edition, CRC Press, 2009.
4. Sharma S.C., "Construction equipment and management, Khanna Publishers, New Delhi, 2011.
5. Ministry of Rural Development, GOI, "Procurement Manual", National Rural Livelihoods Project, 2010
6. Peter Holm Andreasen, "Dynamics of Procurement Management – A Complexity Approach", Copenhagen Business School, 2012

Course Designers:

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18IMPE0**ENVIRONMENTAL IMPACT
ASSESSMENT**Category L T P Credit
PE 3 0 0 3**Preamble**

To impart the knowledge and skills required for understanding the various impacts of infrastructure projects on the environment and expose the students to the various methodologies available to assess and predict the impacts, and to develop the skill to prepare Environmental Impact Assessment report.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Bloom's Level	Expected Attainment Level (%)	Expected Proficiency (Grade)
CO1	Understand the necessity to study the impacts that will be caused by projects or industries and the methods to assess these impacts	Understand	80	B
CO2	Describe the legal requirements of environmental impact assessment for projects	Understand	80	B
CO3	Prepare terms of reference for environmental impact and socio-economic impact for any developmental project	Apply	80	B
CO4	Prepare environmental management plan and risk mitigation plan by considering environmental aspects, impacts and potential hazards respectively for any project	Apply	80	B
CO5	Analyze the environmental impacts specified in the EIA. Report and suggest suitable mitigation measures for any developmental projects	Apply	80	B

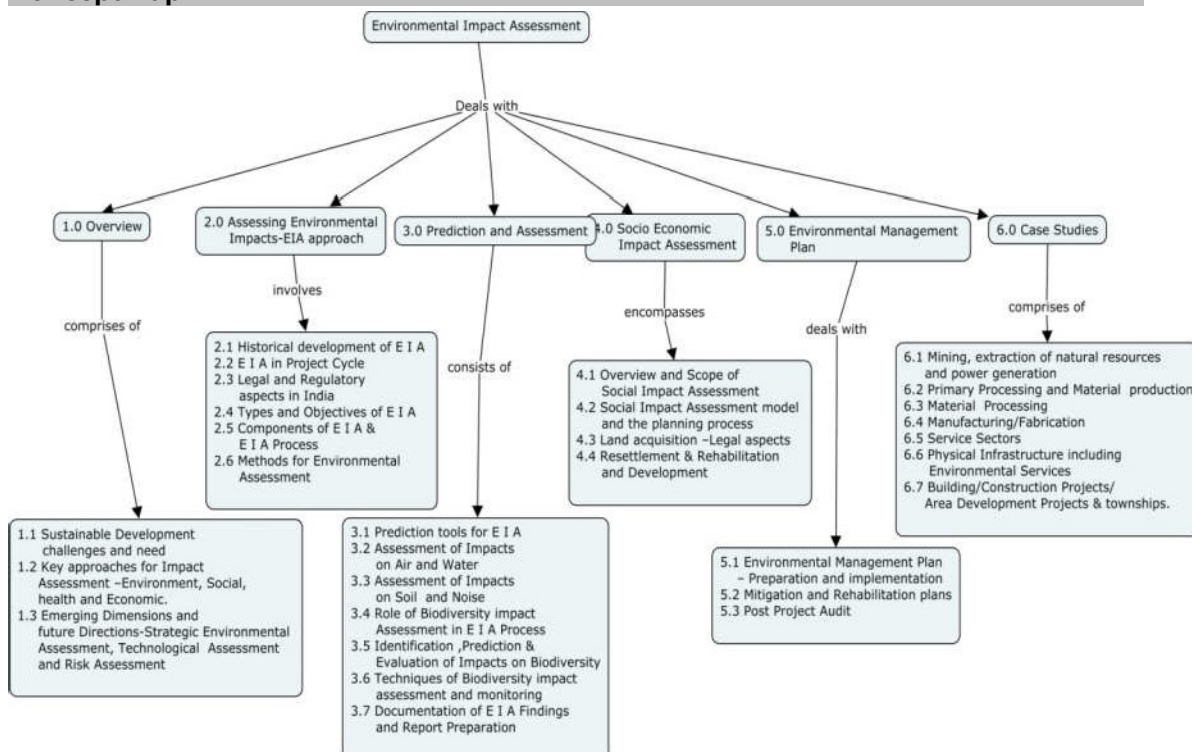
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	---	L	M	---	S	L	L	M	---	---	S	M
CO2	M	L	L	M	---	S	---	L	M	M	L	S	M
CO3	S	M	M	M	M	S	L	M	M	S	M	S	S
CO4	S	S	M	M	---	S	L	M	M	S	M	S	S
CO5	S	S	S	M	---	S	M	M	M	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	50	50	50	60
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map**Syllabus**

OVER VIEW: Sustainable Development challenges and need- Key approaches for Impact Assessment; Emerging Dimensions and future Directions-Strategic Environmental Assessment, Technological Assessment and Risk Assessment. **ASSESSING ENVIRONMENTAL IMPACTS-E I A APPROACH:** Historical development, Legal and Regulatory aspects in India, Types and Objectives, Components, Process of E I A , Prediction and Assessment: tools, impact on air ,water, soil & Noise, Role of Biodiversity impact Assessment, Identification ,Prediction &Evaluation of Impacts on Biodiversity, Techniques of Biodiversity impact assessment, E I A Report Preparation, **SOCIO-ECONOMIC IMPACT ASSESSMENT:** Overview and Scope of Social Impact Assessment, S I A model and the planning process, Land acquisition –Legal aspects, Resettlement & Rehabilitation and Development. **ENVIRONMENTAL MANAGEMENT PLAN:** Preparation and implementation, Mitigation and Rehabilitation plans, Post Project Audit. **CASE STUDIES:** EIA for Mining, extraction of natural resources and power generation, Primary Processing and Material production, Material Processing, Manufacturing/Fabrication, Service Sectors, Physical Infrastructure including Environmental Services, Building/Construction Projects/Area Development Projects & townships.

References

1. Anjaneyulu, Yerramilli, and Valli Manickam, "Environmental impact assessment methodologies", Hyderabad: BS Publications, 2007.
2. Lawrence, D.P., "Environmental Impact Assessment – Practical Solutions to recurrent problems", Wiley-Interscience, New Jersey, 2003.
3. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York, 1996.
4. Petts, J., "Handbook of Environmental Impact Assessment', Vol., I and II, Blackwell science, London, 1999.
5. World Bank – Source Book on Environmental Impact Assessment, 2010
6. www.envfor.nic.in

Course Contents and Lecture Schedule

S.No	Topics	Periods
1.0 OVER VIEW		
1.1	Sustainable Development challenges and need	2
1.2	Key approaches for Impact Assessment –Environment, Social, health and Economic.	1
1.3	Emerging Dimensions and future Directions-Strategic Environmental Assessment, Technological Assessment and Risk Assessment	2
2.0 ASSESSING ENVIRONMENTAL IMPACTS- E I A APPROACH		
2.1	Historical development of E I A	1
2.2	E I A in Project Cycle	1
2.3	Legal and Regulatory aspects in India	1
2.4	Types and Objectives of E I A	1
2.5	Components of E I A & E I A Process	2
2.6	Methods for Environmental Assessment	2
3.0 Prediction and Assessment		
3.1	Prediction tools for E I A	2
3.2	Assessment of Impacts on Air and Water	1
3.3	Assessment of Impacts on Soil and Noise	1
3.4	Role of Biodiversity impact Assessment in E I A Process	1
3.5	Identification ,Prediction &Evaluation of Impacts on Biodiversity	1
3.6	Techniques of Biodiversity impact assessment and monitoring	2
3.7	Documentation of E I A Findings and Report Preparation	1
4.0 SOCIO-ECONOMIC IMPACT ASSESSMENT		
4.1	Overview and Scope of Social Impact Assessment	1
4.2	Social Impact Assessment model and the planning process	1
4.3	Land acquisition –Legal aspects	1
4.4	Resettlement & Rehabilitation and Development	1
5.0 ENVIRONMENTAL MANAGEMENT PLAN		
5.1	Environmental Management Plan – Preparation and implementation	1
5.2	Mitigation and Rehabilitation plans	1
5.3	Post Project Audit	1

6.0 CASE STUDIES		
6.1	EIA for Mining, extraction of natural resources and power generation	1
6.2	EIA for Primary Processing and Material production	1
6.3	EIA for Material Processing	1
6.4	EIA for Manufacturing/Fabrication	1
6.5	EIA for Service Sectors	1
6.6	EIA for Physical Infrastructure including Environmental Services	1
6.7	EIA for Building/Construction Projects/Area Development Projects & townships.	1
TOTAL HOURS		36

Course Designer:

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18IMPF0 TRANSPORTATION PLANNING

Category L T P Credit

PC 3 0 0 3

Preamble

This course focuses on four stages of urban transportation planning i.e. trip generation, trip distribution, mode choice modelling and route assignment. The course will give exposure to land use transport models. The course provides adequate exposure to identify the right type of transportation system needed to cater to the future demand and quantify the same.

Prerequisite

Fundamentals of traffic and transportation engineering, probability and statistics

Course Outcomes

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

COs	Description	Bloom's Level	Expected Attainment level (%)	Expected Proficiency (grade)
CO1	Explain the interrelation between land use pattern and transportation system	Understand	A	80
CO2	Explain transportation system planning process	Understand	A	80
CO3	Estimate trip production and attraction	Apply	A	80
CO4	Undertake efficient mode choice analysis and trip distribution modelling	Apply	A	80
CO5	Perform route assignment in a network	Apply	A	80
CO6	Analyse traffic flow pattern using transport land use models	Analyze	B	80

Mapping with Programme Outcomes

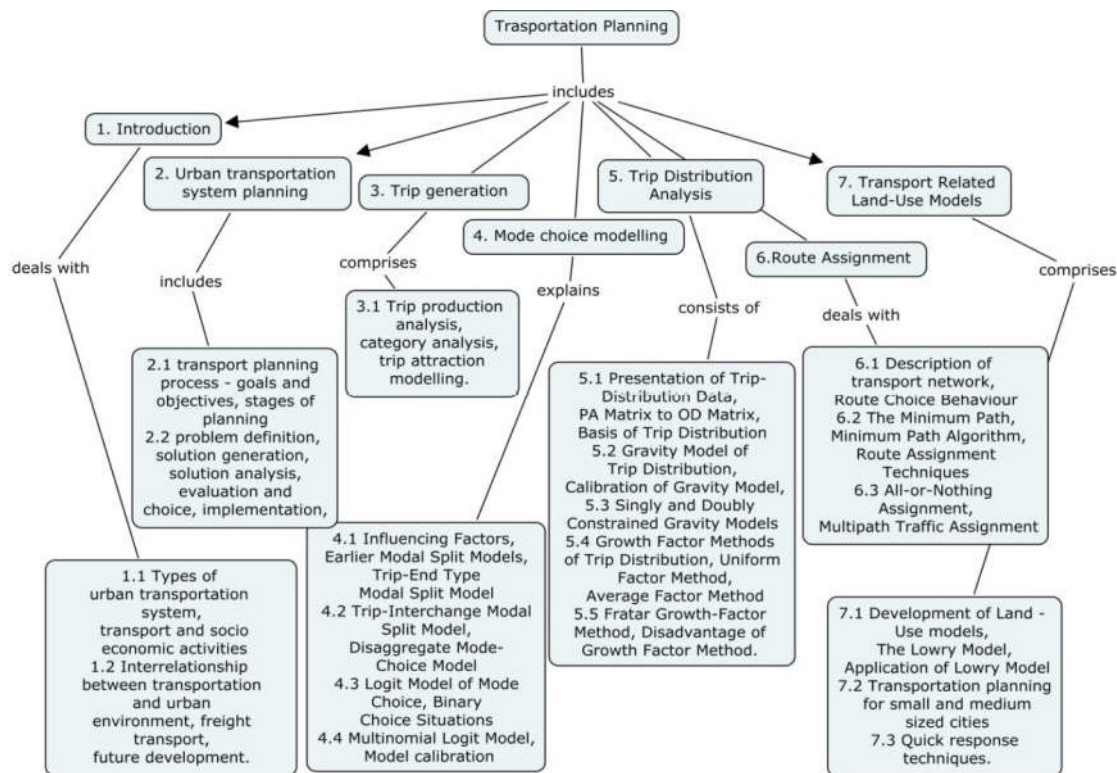
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	M	L	---	---	---	---	L	M	---	---	S	M
CO2	M	L	---	L	---	L	---	---	---	---	M	M	L
CO3	M	M	S	S	---	L	M	L	M	S	M	S	L
CO4	M	M	S	S	---	L	M	---	M	S	---	S	M
CO5	S	L	---	---	---	L	M	---	M	S	M	S	M
CO6	S	L	L	M	---	L	---	L	---	S	M	S	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	60	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Concept Map



Syllabus

Introduction - Types of urban transportation systems, transport and socio economic activities, interrelationship between transportation and urban environment, freight transport, future development. **Transportation System Planning** - Transport planning process, problem definition, solution generation, solution analysis, evaluation and choice, implementation, sequence of activities involved in transportation analysis. Difficulties in transport planning process. **Trip generation** - Trip production analysis, category analysis, trip attraction modelling. **Mode choice modelling** - Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip-Interchange Modal Split Model, Disaggregate Mode-Choice Model, Logit Model of Mode Choice, Binary Choice Situations, Multinomial Logit Model, Model calibration. **Trip Distribution Analysis** - Presentation of Trip-Distribution Data, PA Matrix to OD Matrix, Basis of Trip Distribution, Gravity Model of Trip Distribution, Calibration of Gravity Model, Singly and Doubly Constrained Gravity Models, Methods of Trip Distribution - Uniform Factor Method, Average Factor Method, Growth-Factor Method, Disadvantage of Growth Factor Method. **Route Assignment** - Description of transport network, Route Choice Behaviour, The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques, All-or-Nothing Assignment, Multipath Traffic Assignment, Capacity-Restrained Traffic Assignment. **Transport Related Land-Use Models** - Development of Land - Use models, The Lowry Model, Application of Lowry Model. Transportation planning for small and medium sized cities, Quick response techniques. Remote sensing and GIS in urban planning (Brief Concepts).

References

1. Flaherty, "Transportation Planning and Traffic Engineering", Elsevier India Pvt Ltd., 2006
2. Jason C. Yu, "Transportation Engineering: Introduction to Planning, Design and Operations", Elsevier, 1992.
3. Brase/Brase, "Understandable Statistics 3rd edition", D C Health and Company, Lexington, Massachusetts, Toronto, 1987.

4. Kadiyali L.R, "Traffic Engineering and Transportation Planning" Khanna Publishers, Delhi, 2010.
5. Hutchinson, B.G., "Principles of Urban Transport Systems Planning", McGraw Hill Book Company, 1974.
6. <http://www.nptel.ac.in/downloads/105101008/>

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Introduction	
1.1	Types of urban transportation systems, transport and socio economic activities	1
1.2	Interrelationship between transportation and urban environment, freight transport, future development	2
2.0	Urban transportation system planning	
2.1	transport planning process - goals and objectives, stages of planning	2
2.2	problem definition, solution generation, solution analysis, evaluation and choice, implementation,	2
2.3	Sequence of activities involved in transportation analysis .Difficulties in transport planning process.	1
3.0	Trip generation	
3.1	Trip production analysis, category analysis, trip attraction modelling.	2
4.0	Mode choice modelling	
4.1	Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model	2
4.2	Trip-Interchange Modal Split Model, Disaggregate Mode-Choice Model	1
4.3	Logit Model of Mode Choice, Binary Choice Situations,	1
4.4	Multinomial Logit Model, Model calibration	1
5.0	Trip Distribution Analysis	
5.1	Presentation of Trip-Distribution Data, PA Matrix to OD Matrix, Basis of Trip Distribution,	2
5.2	Gravity Model of Trip Distribution, Calibration of Gravity Model,	1
5.3	Singly and Doubly Constrained Gravity Models,	1
5.4	Growth Factor Methods of Trip Distribution, Uniform Factor Method, Average Factor Method,	2
5.5	Fratar Growth-Factor Method, Disadvantage of Growth Factor Method.	1
6.0	Route Assignment	
6.1	Description of transport network, Route Choice Behaviour, t	2
6.2	The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques,	2
6.3	All-or-Nothing Assignment, Multipath Traffic Assignment,	1
6.4	Capacity-Restrained Traffic Assignment.	2
7.0	Transport Related Land-Use Models	
7.1	Development of Land - Use models, The Lowry Model, Application of Lowry Model.	2
7.2	Transportation planning for small and medium sized cities,	2
7.3	Quick response techniques.	1
7.4	Remote Sensing and GIS for planning	2
Total Hours		36

Course Designers:

- | | | |
|----|----------------------|----------------|
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18IMPG0**INFRASTRUCTURE FINANCE**

Category L T P Credit

PE 2 1 0 3

Preamble

This main objective of the course is to provide an understanding and appreciation of a financing technique that is widely used to finance infrastructure projects today. Project Finance, as it is called, differs quantitatively and qualitatively in many ways as compared to the traditional corporate finance. This course will provide an exposure to this innovative financing method - Project Finance, and its applicability and utility across industries.

Prerequisite

Nil

Course Outcomes

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

Course Outcome		Bloom's Level	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Understand the concept of Profit and Wealth Maximization Function.	Apply	75	B
CO2	Analysis of Statement of Changes in Financial Statement	Apply	75	B
CO3	Analyse Cash Flow with Capital Budgeting Problem	Analyse	75	B
CO4	Analysis of Risk and Financial Leverage	Analyse	75	B
CO5	Determinants of Working Capital, Policy and Financing Policy	Analyse	75	B

Mapping with Programme Outcomes

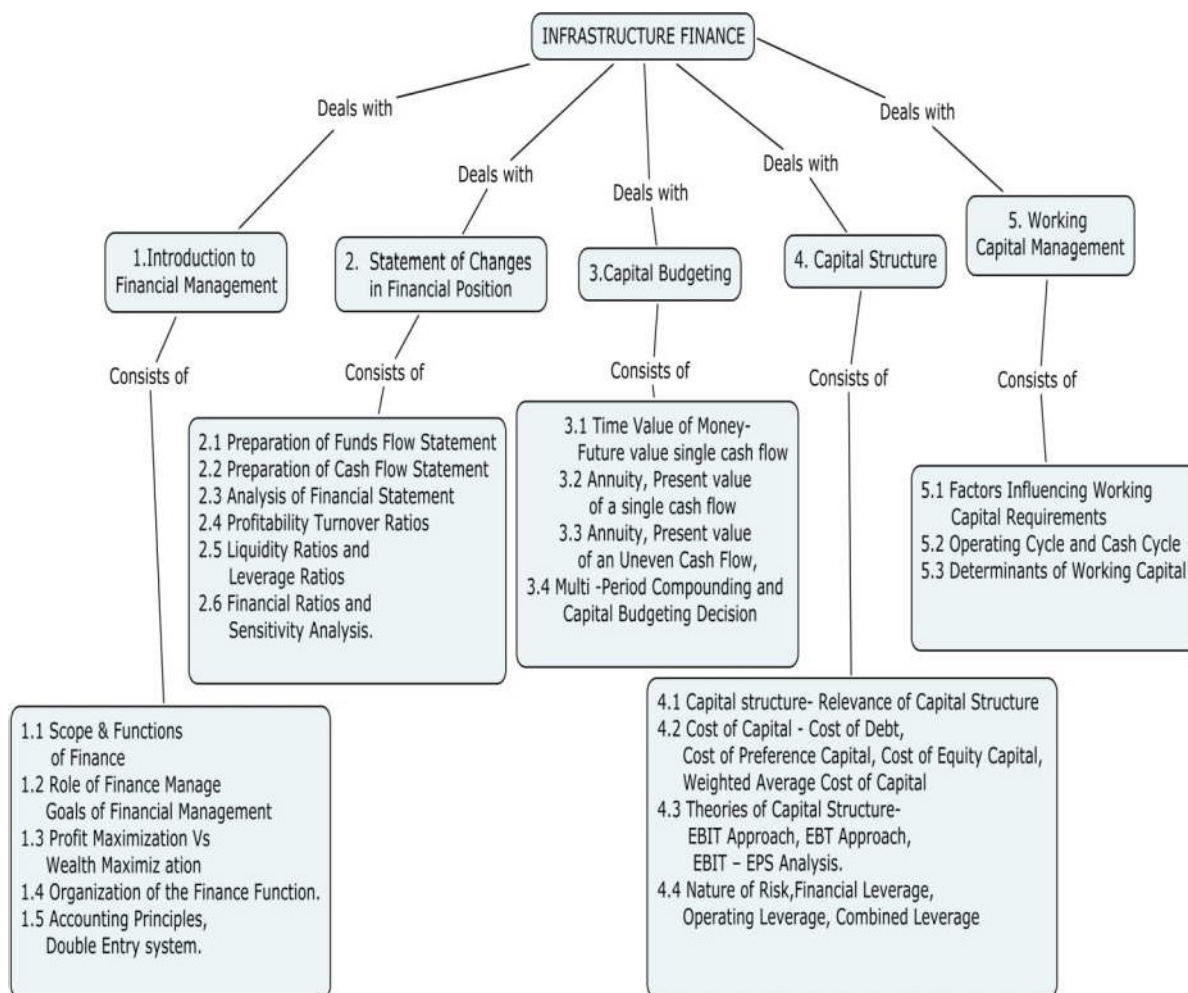
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	L	M	---	---	L	S	---	---	M	L	L	M
CO2	M	L	M	---	---	---	M	---	S	---	L	L	M
CO3	S	S	S	L	---	---	S	---	M	---	L	M	M
CO4	S	S	S	---	---	---	S	---	---	S	L	M	M
CO5	S	S	S	L	---	---	M	---	---	---	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	40	40	40	40
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Concept Map



Syllabus

Introduction to Financial Management: Scope & Functions of Finance, Goals of Financial Management .Organization of the Finance Function. **Accounting Principles** – preparation of journal, ledger, trial balance, Double Entry system, preparation of final account. **Statement of Changes in Financial Position:** Preparation of Fund- Flow Statement, Preparation of Cash- Flow Statement, Analysis of Financial Statement– Profitability Turnover Ratios, Liquidity Ratios, Leverage Ratios, and Financial Ratios, Sensitivity Analysis. **Capital Budgeting:** Concept and importance, factors influencing working capital requirements, Time Value of Money- Future value of a single cash flow, Annuity, Present value of a single cash flow, Annuity, Present value of an Uneven Cash Flow, Multi - Period Compounding. Capital Budgeting Decision. **Analysis of project viability:** Capital structure, Relevance of Capital Structure, Theories of Capital Structure- EBIT Approach, EBT Approach, EBIT – EPS Analysis, Nature of Risk, Financial Leverage, Operating Leverage, Combined Leverage.

References

- 1 Amitabh Mukherjee & Md Hanif, “Modern Accountancy”, TMH Publication, 1981
- 2 Anthony R.N. and Reece J.S., “Accounting for Managers”, Taraporewala, 1987
- 3 Jim McMenamin, “Financial Management – An Introduction”, Taylor and Francis, 2002

- 4 Khan M.Y., Jain P.K, "Financial Management", Tata Mcgraw Hill Publication, 2012
- 5 Maheshwari S.N., "Advance Accountancy" , Vikas Publication, 2007
- 6 Michael Jones, " Accounting for Non Specialists" , Person Education, 2012
- 7 Narayanaswamy, "Financial Accounting – A Managerial Perspective", PHI, 2011
- 8 Prasanna Chandra, "Financial Management", Tata Mcgraw Hill Publication, 2008
- 9 Pande I.M, "Financial Management", Vikash Publication, 2007
- 10 Robert N Anthony, David F Hawkins and Kenneth A , "Accounting", Merchant, 2007

Course Contents and Lecture Schedule

Module No.	TOPICS	NO. OF HOURS
1.0	Introduction to Financial Management	
1.1	Scope & Functions of Finance	1
1.2	Role of Finance Manager- Goals of Financial Management	1
1.3	Profit Maximization Vs Wealth Maximization	1
1.4	Organization of the Finance Function.	1
1.5	Accounting Principles, Double Entry system.	2
2.0	Statement of Changes in Financial Position	
2.1	Preparation of Funds Flow Statement	1
2.2	Preparation of Cash Flow Statement	1
2.3	Analysis of Financial Statement	1
	Tutorial - Financial Statement	2
2.4	Profitability Turnover Ratios	1
2.5	Liquidity Ratios and Leverage Ratios	1
2.6	Financial Ratios and Sensitivity Analysis.	1
	Tutorial- Sensitivity Analysis	2
3.0	Capital Budgeting	
3.1	Time Value of Money-Future value of a single cash flow	1
3.2	Annuity, Present value of a single cash flow	1
3.3	Annuity, Present value of an Uneven Cash Flow,	1
	Tutorial- cash flow	2
3.4	Multi -Period Compounding and Capital Budgeting Decision	2
4.0	Capital Structure	
4.1	Capital structure- Relevance of Capital Structure	1
4.2	Cost of Capital - Cost of Debt, Cost of Preference Capital, Cost of Equity Capital, Weighted Average Cost of Capital	1

	Tutorial- Cost of Capital	2
4.3	Theories of Capital Structure- EBIT Approach, EBT Approach, EBIT – EPS Analysis.	1
	Tutorial- Theories of Capital Structure	2
4.4	Nature of Risk, Financial Leverage, Operating Leverage, Combined Leverage	1
5.0	Working Capital Management	
5.1	Factors Influencing Working Capital Requirements	1
5.2	Operating Cycle and Cash Cycle	1
	Tutorial- Operating Cycle and Cash Cycle	2
5.3	Determinants of Working Capital	1
TOTAL		36

Course Designers:

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18IMPH0 SUSTAINABLE DEVELOPMENT

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course work aims at imparting the knowledge on Sustainable development for a sustainable future. Starting from minimizing the causes for various Environmental issues (like resource degradation, greenhouse gases, industrialization) implementing eco development programmes, promoting Environmental awareness among public/individuals for resource protection and technological innovations for sustainable development are well addressed. The student is expected to understand the environmental issues and demonstrate knowledge of and need for sustainable development, apply knowledge of technological innovations, range of technology and an engineering specialization for achieving sustainable development, and understand the effects of various technologies on global health as they interact with society and culture.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Describe the concept and socio-economic policies of Sustainable Development	Understand	A	80
CO2	Identify the strategies for implementing eco development programmes	Apply	A	80
CO3	Identify different approaches for resource conservation and management	Apply	A	80
CO4	Suggest action plans for implementation of sustainable development	Apply	B	80
CO5	Review technological innovations for their impact on environment and analyze integration in different settings	Analyze	B	80

Mapping with Programme Outcomes

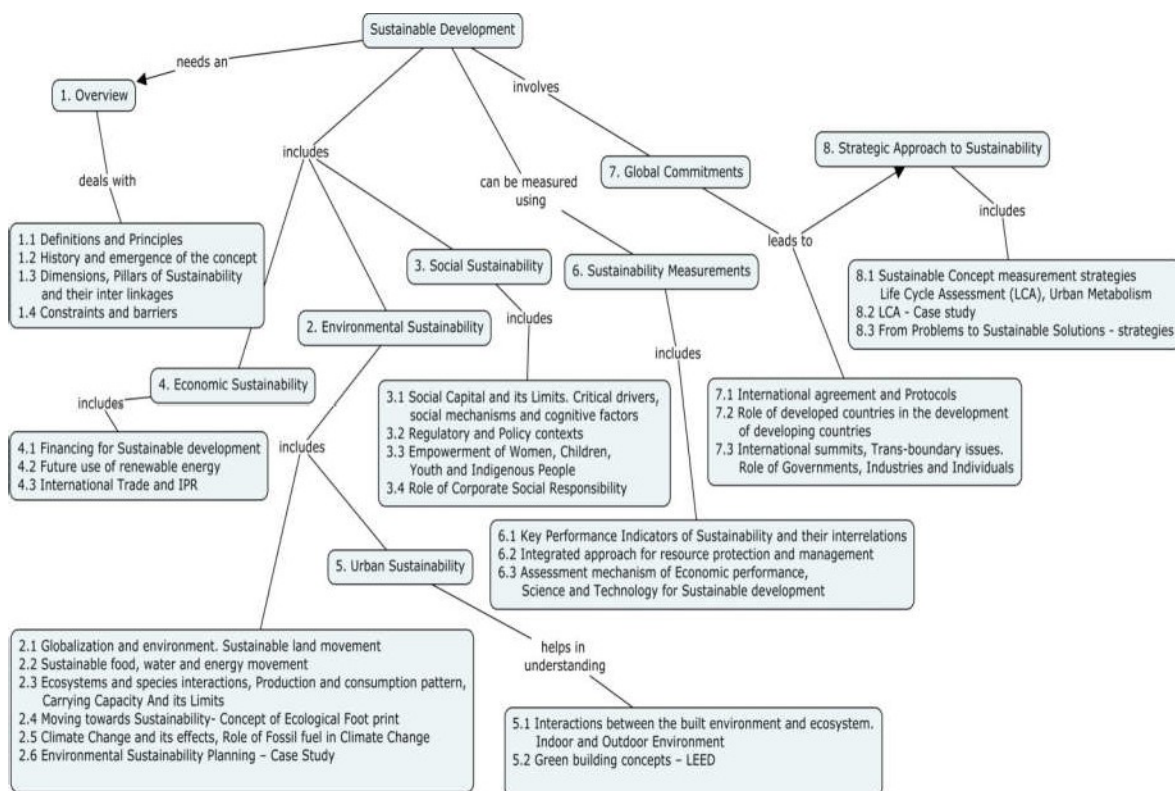
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	---	---	---	---	---	---	---	---	---	---	L	L
CO2	M	M	---	---	---	M	---	---	---	M	M	S	M
CO3	M	M	---	---	---	M	---	---	---	M	M	S	M
CO4	M	M	---	L	---	M	---	M	M	S	M	S	M
CO5	M	M	---	L	---	S	---	M	M	S	L	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	40	40	40	40
Apply	40	30	30	30
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Introduction to Sustainable Development: Definitions and Principles - History and emergence of the concept of Sustainable Development - Dimensions of Sustainability- Pillars of Sustainability and their inter linkages - Constraints and barriers for sustainable development. **Environmental Sustainability:** Globalization and environment. Sustainability movement towards Land, Food, Water and Energy - Ecosystems and species interactions, Production and consumption pattern, Carrying Capacity And its Limits - Moving towards Sustainability- Concept of Ecological Foot print - Climate Change and its effects, Role of Fossil fuel in Climate Change - Environmental Sustainability Planning – Case Study. **Social Sustainability:** Social Capital and its Limits. Critical drivers, social mechanisms and cognitive factors - Regulatory and policy context of Sustainability - Empowerment of Women, Children, Youth and Indigenous People - Role of Corporate Social Responsibility in Sustainable Development. **Economic Sustainability:** Financing for Sustainable development - Future use of renewable energy - International Trade and IPR. **Urban Sustainability:** Understanding interactions between the built environment and ecosystem.

Indoor and Outdoor Environment - Green building concepts – LEED. **Sustainability Measurements:** Key Performance Indicators of Sustainability and their interrelations - Integrated approach for resource protection and management - Assessment mechanism of Economic performance, Science and Technology for Sustainable development. **Global commitments:** International agreement and Protocols - Global Accord, Millennium Development Goals, Sustainable Development Goals and Agenda 21 - Role of developed countries in the development of developing countries - International summits, Trans-boundary issues. Role of Governments, Industries and Individuals. **Strategic approach to sustainability:** Sustainable Concept measurement strategies - Life Cycle Assessment (LCA), Urban Metabolism - LCA - Case study - From Problems to Sustainable Solutions - Strategies

References

1. "Achieving Broad-Based Sustainable Development: Governance, Environment, and Growth with Equity", James H. Weaver, Michael T. Rock and Kenneth Kustere. Kumarian Press, West Hartford, CT. 1997.
2. "Sustainable development", Kirkby. J, O'Keefe P. and Timberlake, Earth Scan Publication, London, 1996.
3. "Silent Spring", Carson, R.L., Houghton Mifflin, 1962.
4. "Natural Capitalism: Creating the Next Industrial Revolution", Paul Hawken, Amory Lovins and Hunter Lovins., Little, Brown & Company, ISBN 978-0-316-35316-8, 1999.
5. "Cradle-to-Cradle: Remaking the Way We Make Things", McDonough, W. & Braungart, M., North Point Press, New York, 2002.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Periods
Introduction to Sustainable Development		
1.1	Definitions and Principles	1
1.2	History and emergence of the concept of Sustainable Development	1
1.3	Dimensions of Sustainability- Pillars of Sustainability and their inter linkages	1
1.4	Constraints and barriers for sustainable development	1
Environmental Sustainability		
2.1	Globalization and environment. Sustainability movement towards land	2
2.2	Sustainability movement towards food, water and energy	2
2.3	Ecosystems and species interactions, Production and consumption pattern, Carrying Capacity And its Limits	1
2.4	Moving towards Sustainability- Concept of Ecological Foot print	1
2.5	Climate Change and its effects, Role of Fossil fuel in Climate Change	2
2.6	Environmental Sustainability Planning – Case Study	1
Social Sustainability		
3.1	Social Capital and its Limits. Critical drivers, social mechanisms and cognitive factors	1
3.2	Regulatory and policy context of Sustainability	1
3.3	Empowerment of Women, Children, Youth and Indigenous People	1
3.4	Role of Corporate Social Responsibility in Sustainable Development	1
Economic Sustainability		
4.1	Financing for Sustainable development	2

4.2	Future use of renewable energy	1
4.3	International Trade and IPR	1
Urban Sustainability		
5.1	Understanding interactions between the built environment and ecosystem. Indoor and Outdoor Environment	1
5.2	Green building concepts – LEED	1
Sustainability Measurements		
6.1	Key Performance Indicators of Sustainability and their interrelations	2
6.2	Integrated approach for resource protection and management	1
6.3	Assessment mechanism of Economic performance, Science and Technology for Sustainable development	1
Global Commitments		
7.1	International agreement and Protocols - Global Accord, Millennium Development Goals, Sustainable Development Goals & Agenda 21	2
7.2	Role of developed countries in the development of developing countries	1
7.3	International summits, Trans-boundary issues. Role of Governments, Industries and Individuals	1
Strategic Approach to Sustainability		
8.1	Sustainable Concept measurement strategies - Life Cycle Assessment (LCA), Urban Metabolism	2
8.2	LCA - Case study	2
8.3	From Problems to Sustainable Solutions - strategies	1
Total Periods		36

Course Designers:

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18IMPJ0

URBANPLANNING AND DESIGN

Category L T P Credit

PE 3 0 0 3

Preamble

Urban planning and design must seek to improve the quality of the life of people living in complex urban conditions, with full respect for indigenous, cultural and social needs. This course is intended to raise the awareness of the components of physical city and the forces that shape it and the planning of urban infrastructure in the urban context.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Understand the characteristics and types of urban settlements	Understand	75	B
CO2	Identify the role of urban planning in development	Understand	75	B
CO3	Explain the theories and models of urban planning	Apply	75	B
CO4	Apply sustainable practices in urban development and planning	Apply	75	B
CO5	Design infrastructure with an understanding of the urban context and development	Apply	75	B

Mapping with Programme Outcomes

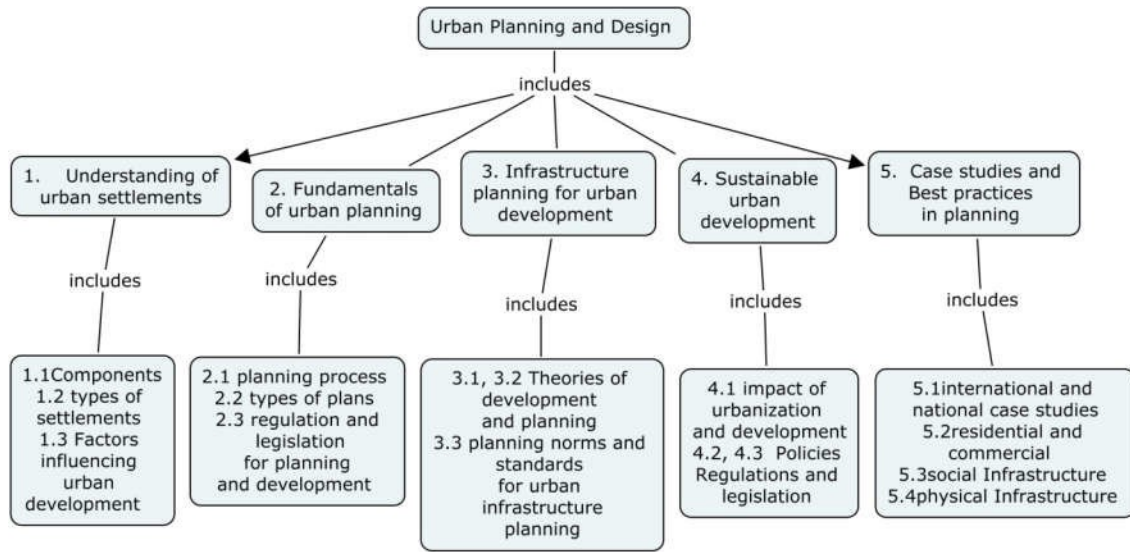
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1.	S	---	---	---	---	---	---	---	---	---	---	M	L
CO2.	S	---	---	---	---	---	---	---	---	---	---	M	M
CO3.	S	---	---	---	---	---	---	L	---	---	---	L	L
CO4.	S	L	L	---	---	M	L	M	---	M	L	M	M
CO5	S	M	L	---	---	M	M	M	---	M	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	60	60	50
Apply	20	20	20	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Introduction to Urban settlements: Definition of settlements, rural and urban settlements – their characteristics ; Basic components, factors influencing urban settlements and their interrelationships; Anatomy & classification of Human settlements based on configuration of shape, function, location, Resource, Population & Occupational structure; Structure and form of Human settlements – Linear, non-linear and circular –Combinations; Structure and form of Human settlements – Linear, non-linear and circular –Combinations; Reasons for development – Major Growth factors – advantages and disadvantages – case studies – factors influencing development / decay; **Urban Planning:** Need, General issues and potentials of urban planning; Planning process and monitoring; Planning machinery in India – levels of planning – Town and country planning act; Types of development plans - Regional plan, Master plan, Structure plan, Zonal Development plan – their scope and content; Urban Development programmes like JNNURM, TNUDP, IDSMT etc; Regulations and legislation in India; Indicators of development and quality of life; role of infra structure in urban development; **Infrastructure planning for urban development:** Theories of urban development ; Land Use models ; Introduction to modes of planning; Various urban development strategies and initiatives in India; smart city – smart grid; National and international guidelines; planning norms and standards for zoning and sub division, physical (transport, water supply, drainage, solid waste management, power etc), social (educational, health, recreational, cultural etc) infrastructure, residential and commercial infrastructure; **Sustainable urban development:** Ecological, environmental and social impact of urbanization and development; Policies and urban design guidelines for new developments; Regulations and legislation w.r.t environment; Environmental Impact assessment – need, process and issues; social and environmental cost benefit; Indicators of ecological analysis; **Case Studies:** Best practices in urban planning and design – inter-national and national case studies; Case studies of Planning of large scale residential, commercial, physical and social Infrastructure at urban level.

References

1. Arthur B Gallion "The urban pattern", CBS publishers, 1983
2. Frederic J. OSBORN -New towns - Arnold whittick – Leonard Hill, 1988
3. Gideon golany "Urban Planning for Arid Zones" , A wiley interscience publication MTP construction, 1995
4. Kevin Lynch," Image of the city" - MIT Press, 1992
5. Koperdekar H.D & Diwan G.R. " Urban and Regional Planning: Principles", practice and law, 1994
6. Pratap Rao M. "Urban Planning theory and practice", cbs,
http: www.bagchee.com/books

Course Contents and Lecture Schedule

Module No.	Topic	No. of lectures
1.0	Introduction to Urban settlements	8
1.1	Definition of settlements, rural and urban settlements – their characteristics ; Basic components, factors influencing urban settlements and their interrelationships	2
1.2	Anatomy and classification of Human settlements based on configuration of shape, function, location, Resource, Population & Occupational structure	2
1.3	Structure and form of Human settlements – Linear, non-linear and circular –Combinations	2
1.4	Reasons for development – Major Growth factors – advantages and disadvantages – case studies – factors influencing development / decay	2
2.0	Urban Planning	6
2.1	Need, General issues and potentials of urban planning; Planning process and monitoring; Planning machinery in India – levels of planning – Town and country planning act	2
2.2	Types of development plans - Regional plan, Master plan, Structure plan, Zonal Development plan – their scope and content; Urban Development programmes like JNNURM, TNUDP, IDSMT etc	2
2.3	Regulations and legislation in India; Indicators of development and quality of life; role of infra structure in urban development	2
3.0	Infrastructure planning for urban development	7
3.1	Theories of urban development ; Land Use models ; Introduction to modes of planning	2
3.2	Various urban development strategies and initiatives in India, smart city – overview	2
3.3	National and international guidelines; planning norms and standards for zoning and sub division, physical (transport, water supply, drainage, solid waste management, power etc), social (educational, health, recreational, cultural etc) infrastructure, residential and commercial infrastructure	3
4.0	Sustainable urban development	6
4.1	Ecological, environmental and social impact of urbanization and development	2
4.2	Policies and urban design guidelines for new developments; Regulations and legislation w.r.t environment	2

4.3	Environmental Impact assessment – need , process and issues ; social and environmental cost benefit; Indicators of ecological analysis	2
5.0	Case Studies	9
5.1	Best practices in urban planning and design – inter-national and national case studies	2
5.2	Case studies of Planning of large scale residential and commercial Infrastructure at urban level	2
5.3	Case studies of Planning of social Infrastructure at urban level	2
5.4	Case studies of Planning of physical Infrastructure at urban level	3
	Total Hours	36

Course Designers:

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18IMPK0

REMOTE SENSING AND GIS

Category L T P Credit

PE 3 0 0 3

Preamble

Remote sensing is small- or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that are wireless, or not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, buoy, or ship). The quality of remote sensing data consists of its spatial, spectral, radiometric and temporal resolutions. A Geographic Information System (GIS) is a system that captures, stores, analyzes, manages and presents data with reference to geographic location data. GIS is the merging of cartography, statistical analysis, and database technology. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data, maps, and present the results of all these operations.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Understand the fundamentals of physics of Remote Sensing and geographical concepts for mapping, analysis and interpretation for problem solving	Understand	80	A
CO2	Understand the various data acquisition systems and collection methods for remote object data information and storage	Understand	80	A
CO3	Explain various techniques of remote data information analysis and interpretation in relation with spatial objects	Apply	75	B
CO4	Understand the concept of GIS with different Data structure and analysis	Understand	75	B
CO5	Explain applications of remote sensing and geographical information system tool in various domains of civil engineering	Apply	75	B

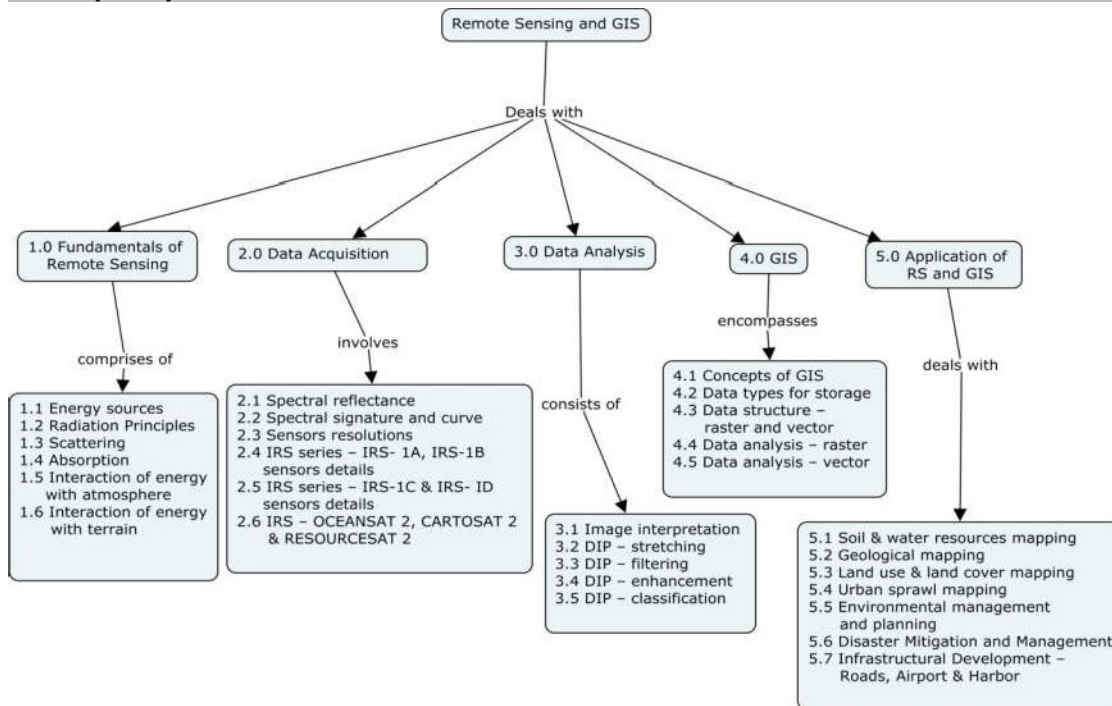
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	---	M	---	---	---	---	---	---	---	---	M	L
CO2	L	---	---	---	---	---	---	---	---	---	---	---	---
CO3	M	M	---	M	---	L	---	M	M	---	---	L	L
CO4	L	---	---	---	L	---	---	---	---	---	---	---	---
CO5	M	M	---	M	S	L	---	M	M	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Concept Map**Syllabus**

Fundamentals of Remote Sensing – Radiation principles, Scattering, Absorption, Interaction of energy with atmosphere and earth; **Data Acquisition** – spectral reflectance and signature, sensors resolutions, IRS series satellites study; **Data Analysis** – Interpretation elements, Digital image processing techniques-stretching, Filtering, Enhancement and classification; **GIS**-concepts, data structure, types of data and analysis; **Applications of RS & GIS** – soil & water resources mapping, geological mapping, land use & land cover mapping, urban sprawl mapping, environmental management and planning studies, and disaster mitigation and management; Application of RS & GIS in infrastructural Development – Roads, Airport & Harbor

References

1. Campbell. J. B, "Introduction to remote sensing", (3rd ed.), The Guilford Press, (2002)
2. Chang. K, "Introduction to Geographic Information System", 4th Edition. McGraw Hill. (2007)
3. Fu, P and J. Sun, "Web GIS: Principles and Applications", ESRI Press. Redlands, CA, (2010)
4. Jensen. J. R, "Remote sensing of the environment: an Earth resource perspective" (2nd ed.). Prentice Hall.(2007).

5. Jensen., J. R. (2005). Digital Image Processing: a Remote Sensing Perspective (3rd ed.), Prentice Hall.
6. Richards. J. A.; and X. Jia, "Remote sensing digital image analysis: an introduction" (4th ed.), Springer, (2006)

Course Contents and Lecture Schedule

S.No	Topic	No.of Lecture
1.0	Fundamentals of Remote Sensing	
1.1	Energy sources	1
1.2	Radiation Principles – Black body radiation, Plank's, Stefan and Boltzman law	1
1.3	Scattering – Raleigh, Mie and Non-selective scattering	1
1.4	Absorption – Atmospheric windows and its significance	1
1.5	Interaction of energy with atmosphere & terrain	2
1.6	Interaction of energy with terrain	2
2.0	Data Acquisition	
2.1	Spectral reflectance – different wave length of EMR	1
2.2	Spectral signature and curve – significance	1
2.3	Sensors resolutions – spectral, spatial, temporal and radiometry	1
2.4	IRS series – IRS- 1A, IRS-1B sensors details, its characteristics and importance	1
2.5	IRS series – IRS-1C & IRS- 1D sensors details, its characteristics and importance	1
2.6	IRS – OCEANSAT 2, CARTOSAT 2 & RESOURCESAT 2	1
3.0	Data Analysis	
3.1	Image interpretation elements – visual and digital	2
3.2	DIP – stretching technique and its importance	1
3.3	DIP – filtering technique and its importance	1
3.4	DIP – enhancement technique and its importance	1
3.5	DIP – classification technique and its importance	2
4.0	GIS	
4.1	Concepts of GIS	1
4.2	Data types for storage – spatial & non spatial	1
4.3	Data structure – raster and vector	2
4.4	Data analysis – raster	1
4.5	Data analysis – vector	1
5.0	Applications of RS & GIS	
5.1	Application of RS & GIS in soil & water resources mapping	2
5.2	Application of RS & GIS in geological mapping	1
5.3	Application of RS & GIS in land use & land cover mapping	2
5.4	Application of RS & GIS in urban sprawl mapping	1
5.5	Application of RS & GIS in environmental management and planning	1
5.6	Application of RS & GIS in Disaster Mitigation and Management	1
5.7	Application of RS & GIS in infrastructural Development – Roads, Airport & Harbor	1
	Total	36

Course Designers:

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18IMPL0 ORGANIZATIONAL BEHAVIOUR

Category L T P Credit
PE 3 0 0 3

Preamble

To impart knowledge on the importance of Organization Behaviour (OB), individual and group dynamics and organizational processes.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Explain the meaning, importance, scope and different approaches of OB	Understand	75	A
CO2	Interpret the categories, dimensions and physiology of emotional intelligence and applications of emotions to OB	Apply	75	A
CO3	Explain the determinants, theories and attributes of personality, apply process and theories for motivation and leadership	Apply	75	B
CO4	Explain the need, importance of Group dynamics in OB and apply the strategies of organizational culture	Apply	75	B
CO5	Enumerate the need, influencing factors for organizational change and strategies for reducing change	Understand	75	A

Mapping with Programme Outcomes

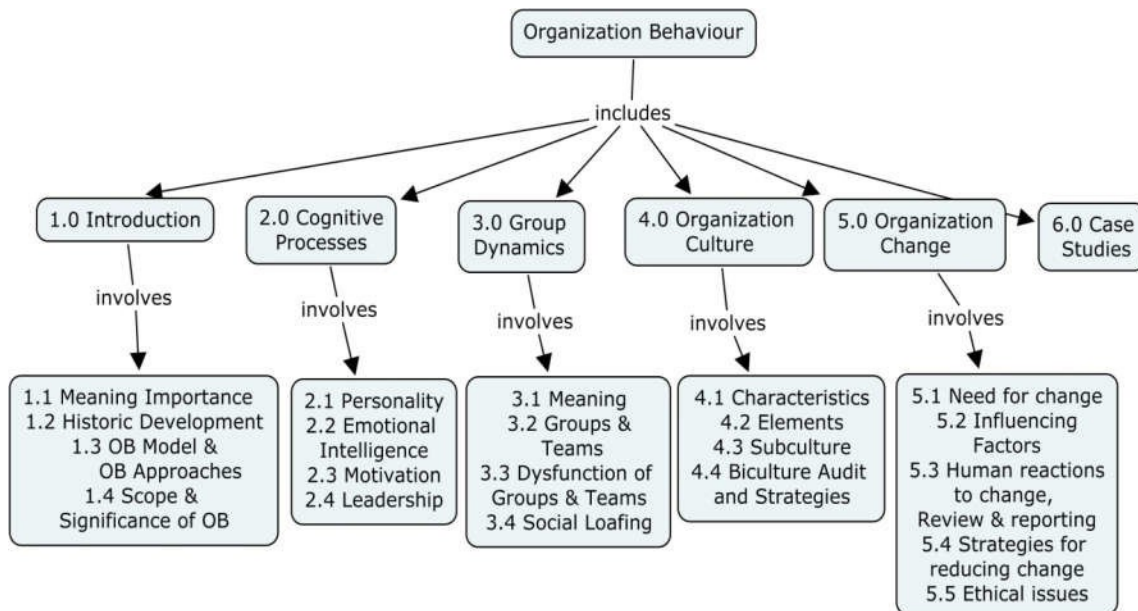
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	---	---	---	---	M	L	M	---	---	---	M	L
CO2	S	L	---	L	---	M	M	M	---	S	M	S	M
CO3	S		M	L	---	M	M	M	---	S	M	S	S
CO4	S	M	M	M	---	M	S	M	---	S	M	S	M
CO5	S	M	M	L	---	M	L	M	L	---	---	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	50	40	40
Apply	30	30	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Introduction to OB- Definition, Meaning and Importance of OB, Historic developments of OB, Hawthorne experiment, Basic OB Model, Different approaches to OB, Contributing disciplines to OB, Scope of OB, Significance of OB. **Personality-** Definition, Origin of the word Personality, Determinants of Personality, Theories of Personality (Psychoanalytic theory, Self theory, Holland's personality theory, Myers Briggs Type Indicators and Big 5 personality theory), Attributes of personality. **Emotional Intelligence-** Definition and Meaning, Categories of intelligence, EI Dimensions, Physiology of EI, OB applications of emotions. **Motivation-** Definition, Meaning, Characteristics of Motivation, Process of Motivation, Theories of Motivation (Maslow's need theory, ERG theory, Herzberg theory, Expectancy theory, Theory X & Y, McClelland's theory of needs, Goal setting theory, Equity theory), Incentives for Motivation. **Leadership** - Definition and Meaning, Styles of leadership, Theories of leadership (Trait theory, Ohio state theory, Managerial grid, Contingency theory, Path goal theory, Leader Member Exchange(LMX), Transactional & transformational leadership theory, Charismatic and Visionary leadership theory), Conflict and resolution. **Group Dynamics** - Definition and Meaning, Difference between Group and Team, Groups in Organization, Team Effectiveness model, Troubles with team, Social loafing- law of requisite variety- Ashby theory. **Organizational Culture-** Meaning and Definition, Characteristics of Organizational culture, Elements of Organizational culture, Organizational sub culture, Artifacts for Organizational culture, Bicultural audit, Strategies to merger different organizational culture. **Organizational Change** - Meaning, need for change, Factors of Organizational change, Lewin's forced field model, Human reactions to change, Organization - Control, review and updating. Resistance to change, Strategies for reducing change, Ethical issues in Organizational change. **Case Studies.**

References

1. Fred Luthans, "Organisational Behaviour", McGraw-Hill International Edition., Tenth Edition, 2005.
2. Kreitner Robert., Kinicki Angelo., "Organisational Behaviour", Illinois, Irwin Inc., 1997.
3. Robbins P.Stephen., "Organizational Behavior", New Delhi, Prentice-Hall of India., Eighth Edition, 1999.
4. Steven L. McShane, Mary Ann Von Glinow, "Organisational Behaviour", New Delhi, Tata McGraw-Hill Edition. third reprint, 2005.
5. Vlad Dimitrov, "Law of Requisite Vorticity in Human Dynamics", <http://www.zulenet.com/vladimirdimitrov/pages/vorticity.html>

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Introduction to Organization Behaviour	
1.1	Definition, Meaning and Importance of OB	1
1.2	Historic developments of OB, Hawthorne experiment	
1.3	Basic OB Model, Different approaches to OB	1
1.4	Contributing disciplines to OB, Scope of OB, Significance of OB	
2.0	Cognitive Processes of Organization Behaviour	
2.1	Personality	
2.1.1	Definition, Origin of the word Personality, Determinants of Personality	1
2.1.2	Theories of Personality - Psychoanalytic theory, Self theory	1
2.1.3	Theories of Personality - Holland's personality theory & Myers Briggs Type Indicators)	1
2.1.4	Theories of Personality - Big 5 personality theory	1
2.1.5	Attributes of personality	
2.2	Emotional Intelligence	
2.2.1	Definition and Meaning, Categories of intelligence	1
2.2.2	EI Dimensions, Physiology of EI	1
2.2.3	OB applications of emotions	
2.3	Motivation	
2.3.1	Definition, Meaning, Characteristics of Motivation	1
2.3.2	Process of Motivation	
2.3.3	Theories of Motivation - Maslow's need theory, ERG theory	1
2.3.4	Theories of Motivation - Herzberg theory, Expectancy theory	1
2.3.5	Theories of Motivation - Theory X & Y, McClelland's theory of needs	
2.3.6	Theories of Motivation - Goal setting theory, Equity theory	1
2.3.7	Incentives for Motivation	
2.4	Leadership	
2.4.1	Definition and Meaning, Styles of leadership	1
2.4.2	Theories of leadership -Trait theory, Ohio state theory	2
2.4.3	Theories of leadership - Managerial grid, Contingency theory	1
2.4.4	Theories of leadership - Path goal theory, Leader Member Exchange(LMX)	2
2.4.5	Theories of leadership - Transactional & transformational leadership theory	1
2.4.6	Theories of leadership - Charismatic and Visionary leadership theory. Conflicts and resolution	1

3.0	Group Dynamics	
3.1	Definition and Meaning	1
3.2	Difference between Group and Team Groups in Organization, Team Effectiveness model	1
3.3	Dysfunction of groups and teams -Troubles with team	1
3.4	Social loafing – law of requisite variety- Ashby theory	2
4.0	Organizational Culture	
4.1	Meaning and Definition, Characteristics of Organizational culture	1
4.2	Elements of Organizational culture	1
4.3	Organizational sub culture, Artifacts for Organizational culture, Bicultural audit	1
4.4	Strategies to merger different organizational culture	1
5.0	Organizational Change	
5.1	Meaning, Need for change	1
5.2	Factors of Organizational change, Lewin's forced field model	1
5.3	Human reactions to change, Organization - Control, review and updating	1
5.4	Strategies for reducing change, Resistance to change	1
5.5	Ethical issues in Organizational change	1
6.0	Case Studies	2
	Total Periods	36

Course Designers

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18IMPM0

**URBAN ENVIRONMENTAL
MANAGEMENT**Category L T P Credit
PE 3 0 0 3**Preamble**

This course work deals with the various environmental issues in an urban scenario. It provides exposure to the urban water resources and its management. It deals with the stages of works involved in a water supply project of a city, safe wastewater collection system for generated wastewater and its management, solid waste and their safe disposal beyond urban limit to be free from pollution is also addressed in the course work.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Understand planning of a city and identify various urban environmental issues	Understand	75	A
CO2	Apply and Prepare project Plans to integrate urban water resource	Apply	75	B
CO3	Develop water resource management using available water resources	Apply	75	B
CO4	Develop sustainable wastewater management concepts comparing with successful models followed in developed nation	Analyze	75	B
CO5	Understand and apply the principles of solid waste management	Apply	75	B

Mapping with Programme Outcomes

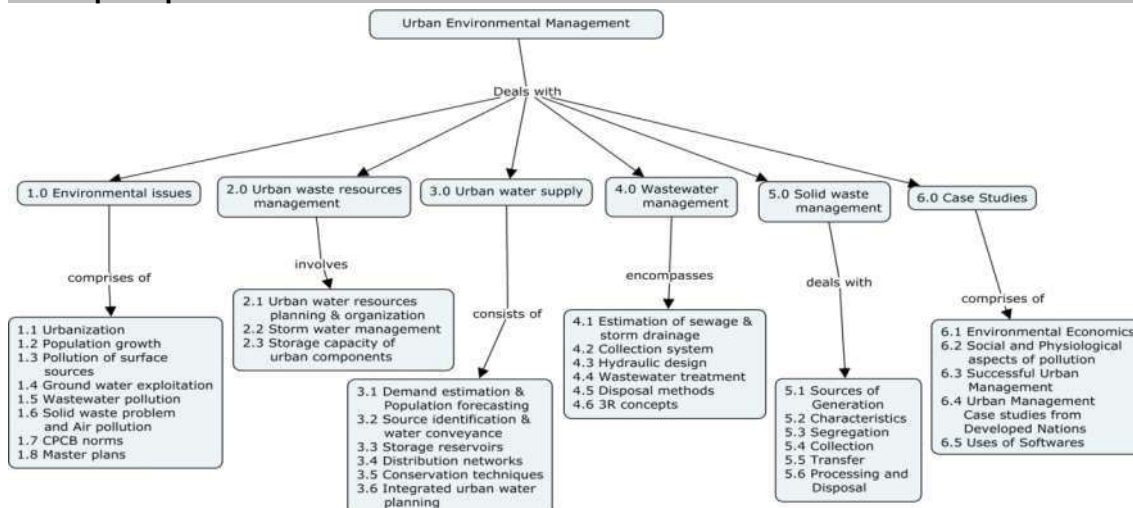
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	---	---	---	---	---	---	L	---	---	---	S	-
CO2	M	L	---	---	---	M	M	---	---	M	L	-	S
CO3	M	L	---	---	---	M	M	---	---	M	L	S	-
CO4	S	M	---	---	---	M	L	---	L	S	L	S	-
CO5	M	L	L	---	---	M	---	L	---	S	L	S	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	50	30	30
Apply	30	30	30	30
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Urban Environmental issues - Urbanization- Population growth scenario – migration – Pollution of surface water resources – rivers, tanks, channels – ground water exploitation – wastewater – characteristics – pollution problems – Solid waste – air pollution – CPCB norms. **Urban master plans** – Planning and organizational aspects. **Urban waste resources management** – Water in urban ecosystem – urban water resources planning and organization aspects – storm water management practices – types of storage – magnitude of storage – storage capacity of urban components – percolation ponds – temple tanks – rainwater harvesting. **Urban water supply** – Demand estimation – population forecasting – source identification – water conveyance – storage reservoirs – fixing storage capacity – Distribution network – types – analysis – computer applications – Conservation techniques – Integrated urban water planning. **Urban wastewater management** – Sewage generation – storm drainage estimation – industry contribution – wastewater collection system – separate and combined system – hydraulic design of sewer and storm drain – wastewater treatment – disposal methods – concept of decentralization – 3R concepts. **Municipal solid waste management** – Sources of solid waste – characteristics – rate of generation – segregation at source – collection of solid waste – methods of collection – route analysis – transfer and transfer stations – processing and disposal of solid waste. **Case Studies**- Environmental economics- Social and Physiological aspects of pollution- Successful Urban Management – models- Urban Management-Case studies from Developed Nations – Softwares.

References

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil “Integrated Solid Waste Management”, McGraw Hill Publishers, New York, 1993.
2. McGhee J., “Water supply and sewerage”, McGraw Hill Publishers, 1991
3. Martin P. Wanelista and Yousef. “Storm Water Management and Operations”, JohnWiley and Sons, 1993.
4. Neil S. Grigg., “Urban Water Infrastructure Planning – Management and Operations”, John Wiley and Sons, 1986.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Environmental issues	
1.1	Urbanization	1
1.2	Population growth scenario and Migration	1

1.3	Pollution of surface water resources	1
1.4	Ground water exploitation– rivers, tanks, channels	1
1.5	Wastewater – characteristics	1
1.6	Solid waste problem and Air pollution	1
1.7	CPCB norms	1
1.8	Urban master plans – Planning and organizational aspects	1
2.0	Urban waste resources management	
2.1	Water in urban ecosystem – urban water resources planning and organization aspects	2
2.2	Storm water management practices	1
2.3	Types of storage – magnitude of storage – storage capacity of urban components – percolation ponds – temple tanks – rainwater harvesting	2
3.0	Urban water supply	
3.1	Demand estimation and Population forecasting	1
3.2	Source identification and water conveyance	1
3.3	Storage reservoirs–fixing storage capacity	1
3.4	Distribution network – types – analysis – computer applications	1
3.5	Conservation techniques	1
3.6	Integrated urban water planning	1
4.0	Urban wastewater management	
4.1	Sewage generation – storm drainage estimation – industry contribution	1
4.2	Wastewater collection system – separate and combined system	1
4.3	Hydraulic design of sewer and storm drain	1
4.4	Wastewater treatment	1
4.5	Disposal methods– concept of decentralization	1
4.6	3R concepts	1
5.0	Municipal solid waste management	
5.1	Sources of solid waste	1
5.2	Characteristics of solid waste and Rate of generation	1
5.3	Segregation at source and Collection of solid waste	1
5.4	Methods of collection – route analysis – transfer and transfer stations	1
5.5	Processing and Disposal of solid waste	1
6.0	Case Studies	
6.1	Environmental economics	1
6.2	Social and Physiological aspects of pollution	1
6.3	Successful Urban Management –models	1
6.4	Urban Management-Case studies from Developed Nations	1
6.5	Softwares	1
Total		36

Course Designers:

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18IMPNO

**GEOTECHNIQUES
FOR
INFRASTRUCTURE**

Category L T P Credit
PE 3 0 0 3

Preamble

Major Infrastructures like bridges, tunnels, Transmission line Towers etc require the use of special Foundations. Often foundations for these works are constructed in poor soils which require remediation work like the use of geo textiles. This course deals with the methods of construction of raft foundation, piles, caissons, diaphragm walls, Foundation for Transmission Towers, Chimneys etc. Also techniques for the construction of Foundations in Expansive soils, Compressible soils and Drainage and Dewatering methods for the construction of Foundations are addressed.

Prerequisite

Fundamentals of Mathematics, knowledge of Geology, Geotechnical Engineering and Foundation Engineering

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Suggest appropriate construction methods for Rafts and Diaphragm walls.	Analyse	75	B
CO2	Suggest suitable construction methods for Foundation for Transmission line Towers and Pile Foundations.	Analyse	75	B
CO3	Suggest suitable Foundation Techniques for Expansive soils and Compressible soils.	Analyse	75	B
CO4	Suggest suitable Drainage and Dewatering Techniques for the construction of Foundations.	Analyse	80	A
CO5	Adopt safety measures during piling and sinking of Caissons.	Analyse	75	B
CO6	Suggest ground remediation work with the use of Geotextiles and Reinforced Earth Walls	Analyse	80	A

Mapping with Programme Outcomes

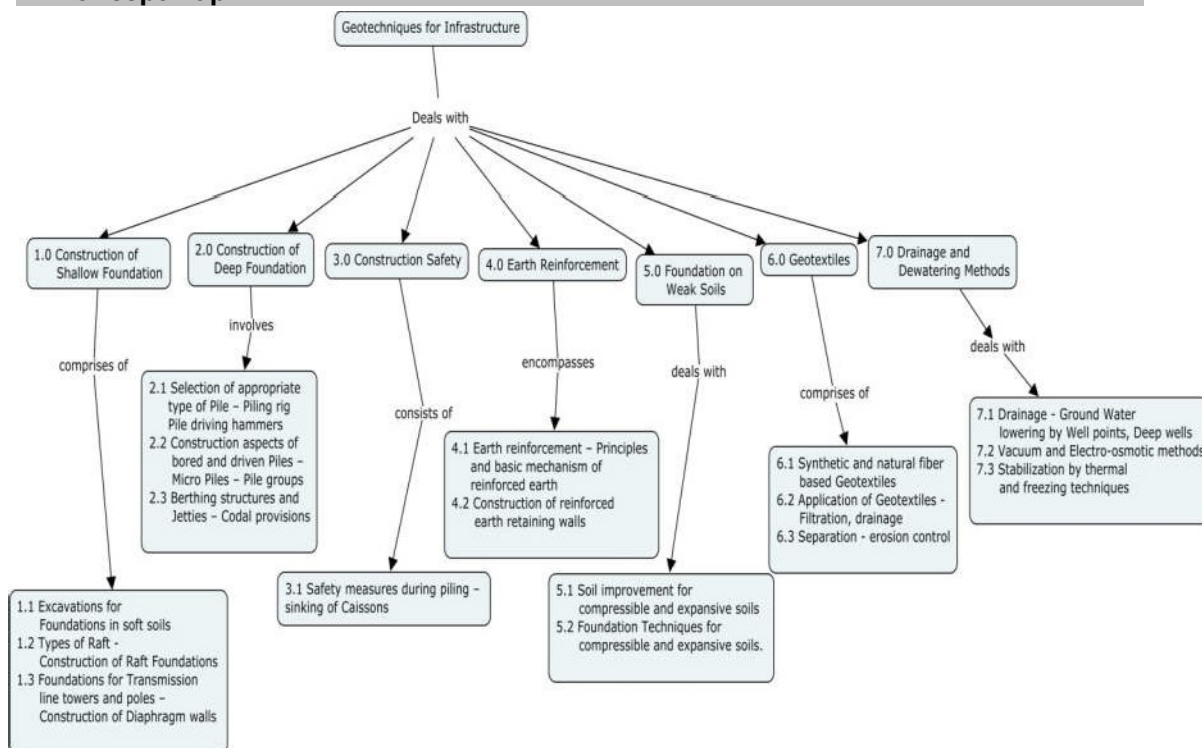
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	M	S	---	---	---	---	---	M	S	L	S	S
CO2	M	M	M	L	---	M	---	---	M	S	L	S	S
CO3	M	M	S	---	---	M	---	---	M	S	L	S	S
CO4	L	L	M	---	---	---	---	---	M	S	L	S	S
CO5	M	L	---	---	---	M	---	---	M	L	L	M	S
CO6	S	S	L	L	---	M	---	---	M	S	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	20	20	20	20
Analyse	30	30	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Concept Map



Syllabus

CONSTRUCTION OF SHALLOW FOUNDATIONS: Excavations for Foundations in soft soils – Recommendations – Types of Raft - Construction of Raft Foundations – Foundations for Transmission line towers and poles – Construction of Diaphragm walls –.

CONSTRUCTION OF DEEP FOUNDATIONS: Selection of appropriate type of Pile – Piling rig – Pile driving hammers - Construction aspects of bored and driven Piles – Micro Piles – Pile groups – Berthing structures and Jetties – Codal provisions.

CONSTRUCTION SAFETY: Safety measures during piling – sinking of Caissons -

EARTH REINFORCEMENT: Earth reinforcement – Principles and basic mechanism of reinforced earth – Construction of reinforced earth retaining walls.

FOUNDATIONS ON WEAK SOILS: Soil improvement and Foundation Techniques for compressible and expansive soils.

GEOTEXTILES: Synthetic and natural fiber based Geotextiles and their applications - Filtration, drainage, separation, erosion control.

DRAINAGE AND DEWATERING METHODS: Drainage - Ground Water lowering by Well points, Deep wells, Vacuum and Electro-osmotic methods— Stabilization by thermal and freezing techniques – Case studies.

References

1. Das, B.M., Principles of Foundation Engineering, Sixth Edition, India Edition, Thomson, 2007.
2. Hans – George Kempfert & Berhane Gebreselassie., Excavation And Foundations in soft soils, Springer.
3. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers & Distributors, New Delhi, 2007.
4. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Ltd., New Delhi, 2007
5. Tomlinson M.J., Pile Design and Construction Practice, Fourth Edition, E & FN SPON an imprint of Chapman & Hall.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	CONSTRUCTION OF SHALLOW FOUNDATIONS	
1.1	Excavations for Foundations in soft soils - recommendations	2
1.2	Types of Raft - Construction of Raft Foundations	2
1.3	Foundations for Transmission line towers and poles – Construction of Diaphragm walls	3
2.0	CONSTRUCTION OF DEEP FOUNDATIONS	
2.1	Selection of appropriate type of Pile – Piling rig – Pile driving hammers	2
2.2	Construction aspects of bored and driven Piles – Micro Piles – Pile groups	2
2.3	Berthing structures and Jetties – Codal provisions	2
3.0	CONSTRUCTION SAFETY	
3.1	Safety measures during piling – sinking of Caissons	2
4.0	EARTH REINFORCEMENT	
4.1	Earth reinforcement – Principles and basic mechanism of reinforced earth	2
4.2	Construction of reinforced earth retaining walls	3
5.0	FOUNDATIONS ON WEAK SOILS	
5.1	Soil improvement for compressible and expansive soils	2
5.2	Foundation Techniques for compressible and expansive soils.	2
6.0	GEOTEXTILES	
6.1	Synthetic and natural fiber based Geotextiles	2
6.2	Application of Geotextiles - Filtration, drainage	2
6.3	Separation - erosion control	2
7.0	DRAINAGE AND DEWATERING METHODS	
7.1	Drainage - Ground Water lowering by Well points, Deep wells	2
7.2	Vacuum and Electro-osmotic methods	2
7.3	Stabilization by thermal and freezing techniques	2
Total hours		36

Course Designer:

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18IMPP0**CONSTRUCTION MATERIALS AND TECHNOLOGY**

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course work gives an exposure on the advanced materials and technologies Used in infrastructure industry.

Prerequisite

Nil

Course Outcomes

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

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency (grade)
CO1	Explain the properties and applications of special concretes, metals, composites, smart and intelligent materials	Understand	80	A
CO2	Identify and explain advanced construction techniques used for sub structure construction	Apply	80	A
CO3	Select appropriate techniques for super structure construction of buildings	Apply	80	A
CO4	Select suitable techniques for construction of special structures	Apply	80	A
CO5	Choose relevant technique for demolition and dismantling works	Apply	80	A

Mapping with Programme Outcomes

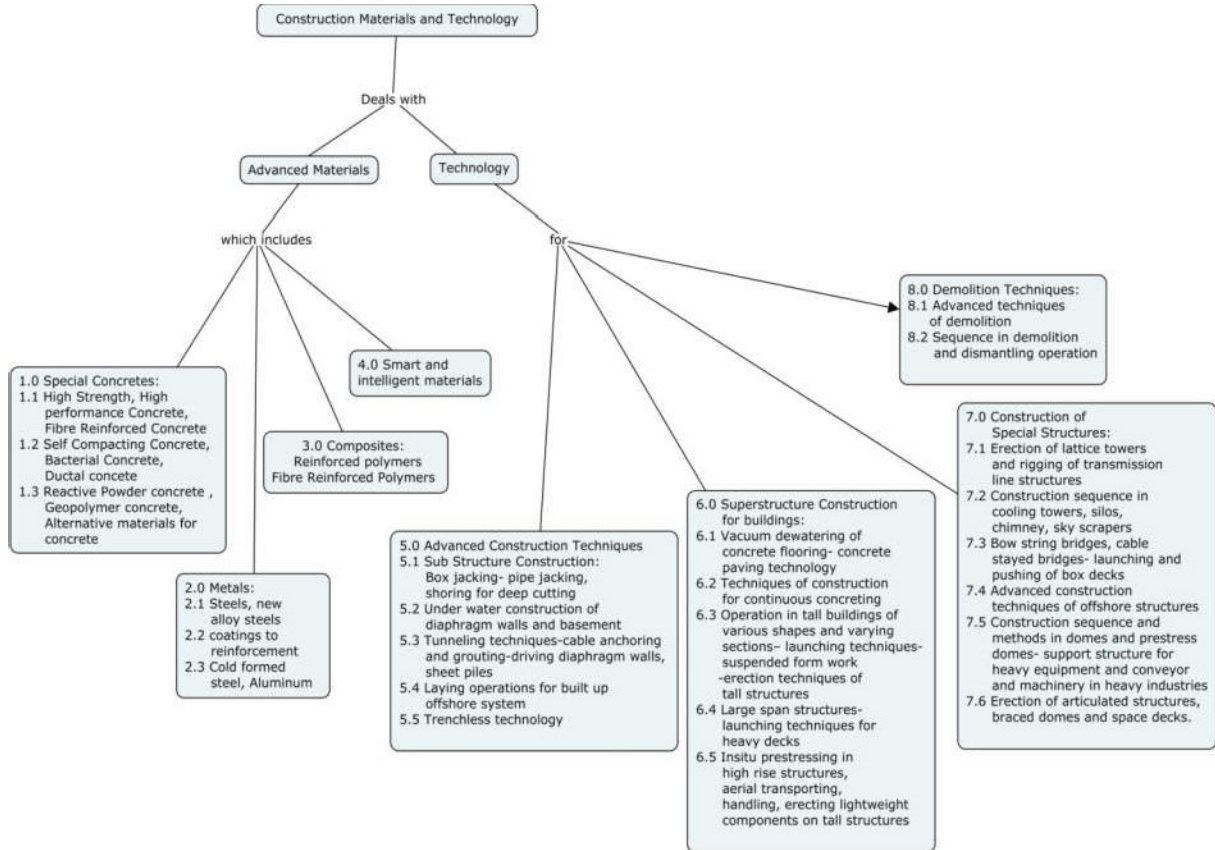
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1.	L	L	---	---	---	---	---	---	---	---	---	L	L
CO2.	L	M	L	---	---	---	M	---	M	M	---	L	L
CO3.	L	M	M	M	---	M	M	L	M	S	M	S	S
CO4.	L	M	M	M	---	M	M	L	M	S	M	S	S
CO5.	L	M	M	M	---	M	M	M	M	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	40	30	30
Apply	30	40	50	50
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map



Syllabus

Special Concretes: Concretes, Behaviour of concretes – High Strength and High Performance Concrete - Fibre Reinforced Concrete, Self Compacting Concrete, Bacterial Concrete, Ductal, Reactive Powder concrete, geopolymer concrete, alternative materials for concrete. **Metals:** Steels –new alloy steels, coatings to reinforcement, Cold formed steel aluminum– applications.

Composites: Reinforced polymers- FRP – applications. **Smart and intelligent materials:** Smart and intelligent materials for intelligent buildings – Special features. **Advanced Construction**

Techniques: Sub Structure Construction: Box jacking- pipe jacking- under water construction of diaphragm walls and basement- tunneling techniques-cable anchoring and grouting-driving diaphragm walls, sheet piles, laying operations for built up offshore system- shoring for deep cutting- large reservoir construction -trenchless technology. **Superstructure Construction for buildings:** Vacuum dewatering of concrete flooring- concrete paving technology- techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections – launching techniques- suspended form work -erection techniques of tall structures, large span structures- launching techniques for heavy decks – insitu prestressing in high rise structures, aerial transporting, handling, erecting lightweight components on tall structures.

Construction of Special Structures: Erection of lattice towers and rigging of transmission line structures- construction sequence in cooling towers, silos, chimney, sky scrapers, bow string bridges, cable stayed bridges- launching and pushing of box decks – advanced construction techniques of offshore structures- construction sequence and methods in domes and prestress domes – support structure for heavy equipment and conveyor and machinery in heavy industries – erection of articulated structures, braced domes and space decks. **Demolition Techniques:** Advanced techniques and sequence in demolition and dismantling.

Course Contents and Lecture Schedule		
Module No.	Topics	No. of Lectures
	Advanced Materials	
1.0	Special Concretes: Concretes, Behaviour of concretes	
1.1	High Strength, High performance Concrete, Fibre Reinforced Concrete –properties & applications	1
1.2	Self Compacting Concrete, Bacterial Concrete, Ductal – properties & applications	1
1.3	Reactive Powder concrete , Geopolymer concrete, Alternative materials for concrete –properties & applications – manufacture, properties & applications	2
2.0	Metals:	
2.1	Steels, new alloy steels – properties & applications	1
2.2	coatings to reinforcement – properties & applications	1
2.3	Cold formed steel, Aluminum – properties & applications	1
3.0	Composites: Reinforced polymers- Fibre Reinforced Polymers - properties & applications	1
4.0	Smart and intelligent materials: Smart and intelligent materials for intelligent buildings	2
	Construction Technologies	
5.0	Advanced Construction Techniques	
5.1	Sub Structure Construction: Box jacking- pipe jacking, shoring for deep cutting	2
5.2	Under water construction of diaphragm walls and basement	2
5.3	Tunneling techniques-cable anchoring and grouting-driving diaphragm walls, sheet piles	2
5.4	Laying operations for built up offshore system	2
5.5	Trenchless technology	1
6.0	Superstructure Construction for buildings:	
6.1	Vacuum dewatering of concrete flooring- concrete paving technology	1
6.2	Techniques of construction for continuous concreting	1
6.3	Operation in tall buildings of various shapes and varying sections – launching techniques- suspended form work -erection techniques of tall structures	2
6.4	Large span structures- launching techniques for heavy decks	1
6.5	Insitu prestressing in high rise structures, aerial transporting, handling, erecting lightweight components on tall structures	2
7.0	Construction of Special Structures:	
7.1	Erection of lattice towers and rigging of transmission line structures	1
7.2	Construction sequence in cooling towers, silos, chimney, sky scrapers	1
7.3	Bow string bridges, cable stayed bridges- launching and pushing of box decks	1
7.4	Advanced construction techniques of offshore structures	1
7.5	Construction sequence and methods in domes and prestress domes-support structure for heavy equipment and conveyor and machinery in heavy industries	2
7.6	Erection of articulated structures, braced domes and space decks.	1
8.0	Demolition Techniques:	
8.1	Advanced techniques of demolition	1
8.2	Sequence in demolition and dismantling operation	1
	Total Hours	36

References

1. Jerry Irvine, "Advanced Construction Techniques", C.A. Rocketr, 1984
2. Patrick Powers, "Construction Dewatering: New Methods and Applications", John Wiley & Sons, 1992
3. Robertwade Brown, "Practical foundation Engineering handbook", McGraw Hill Publications, 1995.
4. Sankar S.K. and Saraswathi. S, "Construction Technology", Oxford University Press, New Delhi, 2008.

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18IMPQ0 LARGE SCALE SYSTEMS PLANNING

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

The aim of this course is to sensitize the students about the basic concepts of systems engineering methodologies to approach the Socio-Techno problems in a holistic manner. This course will address the concepts of cause-effect impacts due to the interrelationships of components and elements of systems in a complex environment.

In the modern society there are great possibilities of creating numerous identical solutions for every need. In this situation assessing the technological solutions using systems science and methodologies would be more appropriate rather than accepting the solutions developed based on 'reductionist' theorems. Usually, unintended impacts in view of energy conservation, economy, safety and environment indulge major crisis for the civil society and government in due course of time during and after implementations. These societal and socio-technological problems are typically large and complex, and hence this course has been called "Large-Scale Planning Systems".

We use the word 'Systems' to refer to the application of systems science and tools associated with this science for problem solving. These tools are also called as 'Systems Engineering Methodologies'. Thus systems engineering refers not only to physical systems and devices but to human and social systems too. Thus we must consider the total impact of any technological system on society as an inherent part of 'Systems Engineering'.

The systems approach to problem solving emphasizes interactions and interrelations among diverse parts of problems. Therefore it may be used to approach large and complex societal problems in a unified fashion. This would be contrasted with fragmented approach to eliminating symptoms of social ills that usually appear in our social systems and planning.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will:

COs	Description	Blooms Levels	Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Identify tools for process of forecasting and assessment on the intended and unintended impacts on policies and technological solutions	Understand	80	A
CO2	Participate and coordinate in group discussions in organizations	Apply	70	B
CO3	Understand and apply the components and elements involved in DPR, FR, EIA, EMS and Resettlement & Rehabilitation programs.	Apply	70	B
CO4	Understand and apply the problem situation for higher level policy discussion on any societal issues seamlessly in all domains	Apply	70	B
CO5	Understand and apply the problem situation for higher level policy discussion on any technological issues seamlessly in all domains	Apply	70	B

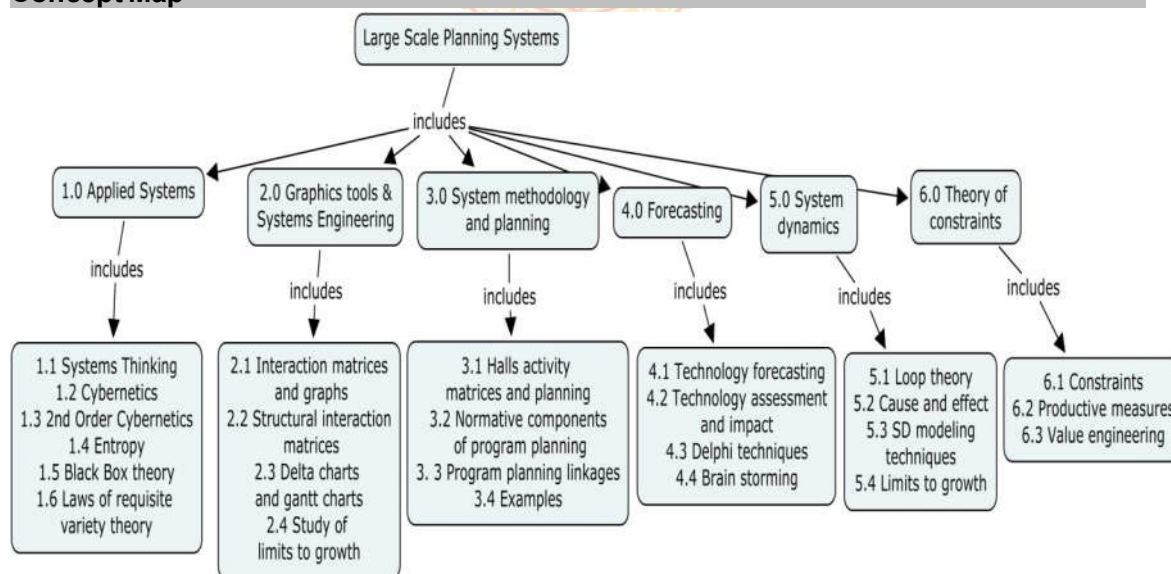
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	---	---	---	---	---	---	---	---	---	---	M	M
CO2	L	M	---	---	---	L	---	M	---	M	---	S	S
CO3	L	M	L	---	---	L	---	M	L	M	M	M	M
CO4	L	M	L	---	---	L	---	M	L	M	M	S	M
CO5	L	M	---	---	---	M	---	---	---	M	---	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Concept Map**Syllabus**

Applied Systems: Systems thinking, Cybernetics, 2nd order cybernetics, Entropy, Black Box theory, Laws of requisite variety theory. **Graphics tools and systems engineering:** Interaction matrices and graphs, Structural interaction matrices, Delta charts and Gantt charts, Study of limits to growth. **System methodology and planning:** Halls activity matrices and planning, Normative components of program planning, Program planning linkages, Examples. **Forecasting:** Technology forecasting, Technology assessment and impact, Delphi techniques, Brain storming. **System dynamics:** Loop theory, Cause and

effect, SD modeling techniques, Limits to growth. **Theory of constraints:** Constraints, Productive measures, Value engineering.

References

1. Andrew P. Sage, "Methodology for Large-Scale Systems", McGraw Hill Publication, 1977.
2. Anthony N. Michel, Richard K. Miller "Qualitative Analysis of Large Scale Dynamical Systems", Academic Press Inc. 1977
3. Heylighen. F "Cybernetics and Systems theory", Journal of Social and Evolutionary systems, 1996
4. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT /CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1982
5. Warfield, J. N. "An Introduction to Systems Science", World Scientific, Singapore, 2006.

Course Contents and Lecture Schedule

Module No.	Topic	Periods
1.0	Applied Systems	
1.1	Systems thinking	1
1.2	Cybernetics	2
1.3	2 nd order cybernetics	1
1.4	Entropy	2
1.5	Black Box theory	1
1.6	Laws of requisite variety theory	1
2.0	Graphics tools and systems engineering	
2.1	Interaction matrices and graphs	2
2.2	Structural interaction matrices	2
2.3	Delta charts and Gantt charts	1
2.4	Study of limits to growth	1
3.0	System methodology and planning	
3.1	Halls activity matrices and planning	2
3.2	Normative components of program planning	2
3.3	Program planning linkages	2
3.4	Examples	1
4.0	Forecasting	
4.1	Technology forecasting	1
4.2	Technology assessment and impact	1
4.3	Delphi techniques	1
4.4	Brain storming	1
5.0	System dynamics	
5.1	Loop theory	2
5.2	Cause and effect	1
5.3	SD modeling techniques	2
5.4	Limits to growth	1
6.0	Theory of constraints	
6.1	Constraints	2
6.2	Productive measures	1
6.3	Value engineering	2
Total Periods		36

Course Designers:

- | | | |
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