BOARD OF STUDIES MEETING

M.E Degree (Infrastructure Engineering and Management) Program

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2008 certified
Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
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CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (Infrastructure Engineering and Management) PROGRAM

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2011-2012 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001-2008 certified
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Board of Studies meeting 27.08.11

Department of Civil Engineering

Graduating Students of M.E program of Infrastructure Engineering and Management will be able to

1. Understand, Apply, Analyze and Design the infrastructural requirements in structural, transportation and environmental engineering
2. Plan, Schedule and Monitor the infrastructural projects through construction management techniques
3. Maintain and rehabilitate infrastructural engineering projects

Thiagarajar College of Engineering, Madurai-625015

Department of Civil Engineering (Infrastructure Engineering and Management)

Scheduling of Courses

Semester	Theory Courses						Practical / Project	
4th (12)							IM41 Project Phase- II 0:12	
3rd (16)	IM31 Construction Planning, Scheduling and Management 3:1	Elective V 4:0	Elective VI 4:0				IM34 Project Phase – I 0:4	
2nd (25)	IM21 Infrastructure Management 4:0	IM22 Management of Human resource, safety and Quality 4:0	Elective I 4:0	Elective II 4:0	Elective III 4:0	Elective IV 4:0	IM27 Seminar/Lab 0:1	
1st (25)	IM11 Applied Statistics and Optimization 3:1	IM12 Construction material and Technology 4:0	IM13 Traffic Engineering and Transport Planning 3:1	IM14 Geotechniques for Infrastructure 4:0	IM15 Quantitative methods in management 3:1	IM16 Urban Environmental Management 4:0	IM17 Concrete Technology & Structural Engineering Laboratory 0:1	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

M.E DEGREE (Infrastructure Engineering and Management) PROGRAM

SUBJECTS OF STUDY

(For the candidates admitted from 2011-2012 onwards)

FIRST SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
IM11	Applied Statistics and Optimization	BS	3	1	-	4
IM12	Construction material and Technology	DC	4	-	-	4
IM13	Traffic Engineering and Transport Planning	DC	3	1	-	4
IM14	Geotechniques for Infrastructure	DC	4	-	-	4
IM15	Quantitative methods in management	DC	3	1	-	4
IM16	Urban Environmental Management	DC	4	-	-	4
PRACTICAL						
IM17	Concrete Technology & Structural Engineering Laboratory	P	-	-	3	1
Total			**21**	**3**	**3**	**25**

BS : Basic Science
DC : Department Core
DE : Department Elective
GE : General Elective
L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

SECOND SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
IM21	Infrastructure Management	DC	4	-	-	4
IM22	Management of Human resource, safety and Quality	DC	4	-	-	4
IM23	Elective I	DE	4	-	-	4
IM2X	Elective II	DE	4	-	-	4
IM2Y	Elective III	DE	4			4
IM2Z	Elective IV	DE	4			4
PRACTICAL						
IM27	Seminar/Lab	P	-	-	3	1
Total			**24**	**-**	**3**	**25**

THIRD SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
IM31	Construction Planning, Scheduling and Management	DC	3	1	-	4
IM3X	Elective V	DE	4	-	-	4
IM3Y	Elective VI	DE	4	-	-	4
PRACTICAL						
IM34	Project Phase- I	P	-	-	12	4
Total			**11**	**1**	**12**	**16**

FOURTH SEMESTER

Subject code	Name of the subject	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
IM41	Project Phase- II	P	-	-	36	12
Total			**-**	**-**	**36**	**12**

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

M.E DEGREE (Infrastructure Engineering and Management) PROGRAM

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2011-2012 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	IM11	Applied Statistics and Optimization	3	50	50	100	25	50
2	IM12	Construction material and Technology	3	50	50	100	25	50
3	IM13	Traffic Engineering and Transport Planning	3	50	50	100	25	50
4	IM14	Geotechniques for Infrastructure	3	50	50	100	25	50
5	IM15	Quantitative methods in management	3	50	50	100	25	50
6	IM16	Urban Environmental Management	3	50	50	100	25	50
PRACTICAL								
7	IM17	Concrete Technology & Structural Engineering Laboratory	3	50	50	100	25	50

* CA evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

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

Sub Code	Lectures	Tutorial	Practical	Credit
IM11	3	1	-	4

IM11 Applied Statistics and Optimization **3:1**

(Common to EN11)

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 stastical 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

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

1. Calculate the value which relates the dependent variable to one or more independent variables.
2. State a statistical inference from information contained in random samples about the populations from which the samples were obtained.
3. Demonstrate the characteristic of the population with degree of confidence from the random sample.
4. Determine the most reliable results of the population based on all the information available in a sample using non-parametric methods.
5. Calculate the experimental error and hence to control the extraneous variables involved in the experiment.

6. Determine the optimum values of unconstrained optimization problems using search methods.

Assessment Pattern

Sl.No.	Bloom's Category	Test I	Test II	Test III / End semester examination
1.	Remember	10	10	10
2.	Understand	30	30	30
3.	Apply	60	60	70
4.	Analyze	0	0	0
5.	Evaluate	0	0	0
6.	Create	0	0	0

Course Level Learning Objectives

Remember

1. Define Multiple Correlations.
2. What are estimators?
3. Define one tailed and two–tailed tests.
4. Mention the formula to test the hypothesis using Kolmogorov-smirnov test.
5. What is the aim of design of experiments?

Understand

1. In a large city A, 20% of a random sample of 900 school boys had a slight physical defect. In another large city B, 18.5% of a random sample of 1600 school boys had the same defect. Identify whether the difference between the proportions is significant or not.

2. The following information was obtained in a sample of 40 small general shops:

	Shops in areas	
	Urban	Rural
Owned by Men	17	18
Owned by Women	3	12

Discuss is it possible to say that there are more women owners in rural areas than in urban areas? Use Yate's Correction for continuity.

3. The following arrangement indicates whether sixty consecutive care which went by the toll booth of a bridge had local plates,L,or out-of state plates O: L L O L L L L O O L L L L O L O O L L L L O L O O L L L L L O L L L O L O L L L L O O L O O O O L L L L O L O O L L L O. Illustrate whether this arrangement of 's and O's may be regarded as random by using the level of significance $\alpha = 0.05$.
4. Comparing two kinds of emergency flares, a consumer testing service obtained the following burning times(rounded to the nearest tenth of a minute)

   Brand C : 19.4, 21.5, 15.3, 17.4, 16.8, 16.6, 20.3, 22.5, 21.3, 23.4, 19.7, 21.0.

   Brand D : 16.5, 15.8, 24.7, 10.2, 13.5, 15.9, 15.7, 14.0, 12.1, 17.4, 15.6, 15.8 .

   Use the Mann-Whitney test and a level of significance of 0.01 to check whether it is reasonable to say that there is no difference between the true average burning times of the two kinds of flares.
5. The following table shows the lives in hours of four brands of electric lamps brand.

   A: 1610 1610 1650 1680 1700 1720 1720 1800
   B: 1580 1640 1640 1700 1750
   C: 1460 1550 1600 1620 1640 1660 1740 1820
   D: 1510 1520 1530 1570 1600 1680.

   Perform an analysis of variance to test the homogeneity of the mean lives of the four brands of lamps.
6. To determine the effect on taste of three different factors in manufacturing soft-drink cans, an experiment was performed where the taste of one soft drink was rated by a judge on a scale from 1 to 10. The results are as follows:

A Lubricant	B Heat	C Resin	Ratings	
			Rep.1	Rep.2
Fresh	Unheated	A	6	8
Fresh	Unheated	B	8	7
Fresh	Heated	A	9	9
Fresh	Heated	B	1	2

Aged	Unheated	A	6	7
Aged	Unheated	B	6	8
Aged	Heated	A	9	8
Aged	heated	B	2	3

Perform an analysis of variance and interpret the result.

Apply

1. If x_1, x_2 ,… x_n are random observations on a Bernoulli variable x taking the value 1 with probability θ and the value 0 with probability (1- θ), show that $\frac{\tau(\tau-1)}{n(n-1)}$ is an unbiased estimate of θ^2 where $\tau=\sum_{i=1}^{n} x_i$.

2. Calculate the M.L.E of the parameter α of the population having the density function $f(x,y)=\frac{2}{\alpha^2}(\alpha-x)$,0<x< α for a sample of unit size (single sample) and also Show that the estimate is biased.

3. Examine whether the two samples for which the data are given in the following table could have been drawn from populations with the same SD.

	Size	S.D
Sample 1	100	5
Sample 2	200	7

4. The heights of 10 males of a given locality are found to be 175, 168, 155, 170, 152, 170, 175, 160, and 165 cm. Based on this sample, determine the 95% confidence limits for the height of males in that locality.

5. The following are the number of minutes it took a sample of 15 men and 12 women to complete the application form for a position.

   Men: 16.5, 20.0, 17.0, 19.8, 18.5, 19.2, 19.0, 18.2, 20.8, 18.7, 16.7, 18.1, 17.9, 16.4, 18.9.

   Women: 18.6, 17.8, 18.3, 16.6, 20.5, 16.3, 19.3, 18.4, 19.7, 18.8, 19.9, 17.6.

Apply the Mann-Whitney test at the level of significance $\alpha = 0.05$ to the null hypothesis that the two samples come from identical population.

6. The following are the number of misprints counted on pages selected at random from the Sunday editions of a newspaper:

   April 11: 4, 10, 2, 6, 4, 12
   April 18: 8, 5, 13, 8, 8, 10
   April 25: 7, 9, 11, 2, 14, 7

   Apply Kruskal-Wallis test at the level of significance $\alpha = 0.05$ to test the null hypothesis that the three samples come from identical populations against the alternative that the compositors and/or proofreaders who worked on the three editions are not equally good.

7. To determine optimum conditions for a plating bath, the effects of sulfone concentration and bath temperature on the reflectivity of the plated metal are studied in a 2x5 factorial experiment. The results of three replicates are as follows:

Concentration (grams/liter)	Temperature (degrees F)	Rep.1	Rep.2	Rep.3
5	75	35	39	36
5	100	31	37	36
5	125	30	31	33
5	150	28	20	23
5	175	19	18	22
10	75	38	46	41
10	100	36	44	39
10	125	39	32	38
10	150	35	47	40
10	175	30	38	31

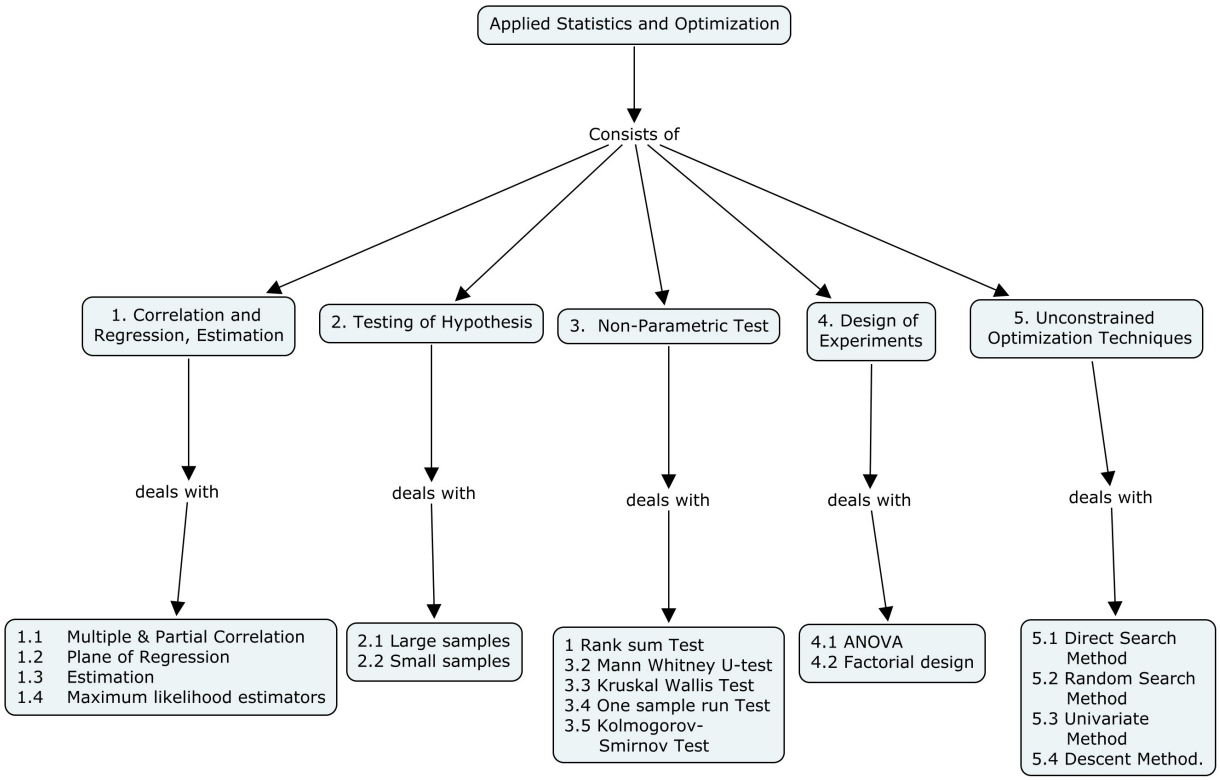
Determine the bath condition or conditions that produce the highest reflectivity.

8. The following data resulted from an experiment to compare three burners B_1, B_2, B3. A latin square design was used as the tests were made on 3 engines and were spread over 3 days.

	Engine 1	Engine 2	Engine 3
Day 1	B_1-16	B_2-17	B_3-20
Day 2	B_2-16	B_2-21	B_1-15
Day 3	B_2-15	B_1-12	B_2-13

Test the hypothesis and determine whether there is any difference between the burners.

Concept map



Course content and Lecture schedule

S.No	Topics	No.of Lectures
	Correlation & Regression Analysis, Sampling Distribution & Estimation	
1.1	Multiple and Partial Correlation	1
1.2	Yules notation, plane of regression	1
1.3	Coefficient of partial and multiple correlation-properties	1
1.4	Sampling-distribution statistics	2
1.5	Standard error, point and interval estimation for population mean, variance	2
1.6	Maximum likelihood estimators	1
	Testing of Hypothesis	
2.1	Testing of hypothesis-inferences concerning to means, variances	2

	and proportions	
2.2	t-test	2
2.3	Chi-Square test	2
2.4	F-test	2
	Non Parametric Tests	
3.1	Sign test of paired data	1
3.2	Rank Sum test	1
3.3	Mann Whitney U-test	1
3.4	Kruskal Wallis test	2
3.5	One sample run test	1
3.6	Kolmogorov-Smirnov test	2
	Design of Experiments	
4.1	Analysis of Variance-One way classification	1
4.2	Two way classification	2
4.3	Block randomized design	1
4.4	Latin Square design	1
4.5	Factorial design	2
4.6	Test of Significance of main and interaction effects	1
	Unconstrained Optimization Techniques	
5.1	Direct Search Method	1
5.2	Random Search Method	1
5.3	Univariate Method	1
5.4	Pattern search Method	2
5.5	Descent Method	1
5.6	Steepest Descent Method	2
	Total	**40**

Syllabus

Correlation & Regression Analysis, Sampling Distribution & Estimation Multiple and Partial Correlation,Yules notation, plane of regression, Coefficient of partial and multiple correlation-properties, 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, Factorial design, Test of Significance of main and interaction effects. **Unconstrained Optimization Techniques** Direct Search Method, Random Search Method, 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 Designers:

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Sub Code	Lectures	Tutorial	Practical	Credit
IM12	4	0	0	4

IM12 Construction Materials and Technology 4:0

Preamble

This course work deals with the advanced materials and technologies used in infrastructure industry.

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

1. Understand the properties and behaviour of special concretes, metals, composites , smart and intelligent materials
2. Know advanced construction techniques used for sub structure construction
3. Select appropriate techniques for super structure construction of buildings
4. Understand the techniques used for construction of special structures
5. Know the various techniques used in demolition and dismantling works

Assessment Pattern

S. No.	**Bloom's Category**	**Test 1**	**Test 2**	**End - semester Examination**
1.	Remember	20	20	20
2.	Understand	50	40	30
3.	Apply	30	40	50
4.	Analyze	0	0	0
5.	Evaluation	0	0	0
6.	Create	0	0	0

Course Level Learning Objectives:

Remember:

1. Differentiate between high strength and high performance concrete
2. Mention two properties of ductal
3. Mention the ingredients of reactive powder concrete

4. Differentiate between box jacking and pipe jacking
5. Mention the limitations of vacuum dewatering technique
6. What do you understand by the term trenchless technology

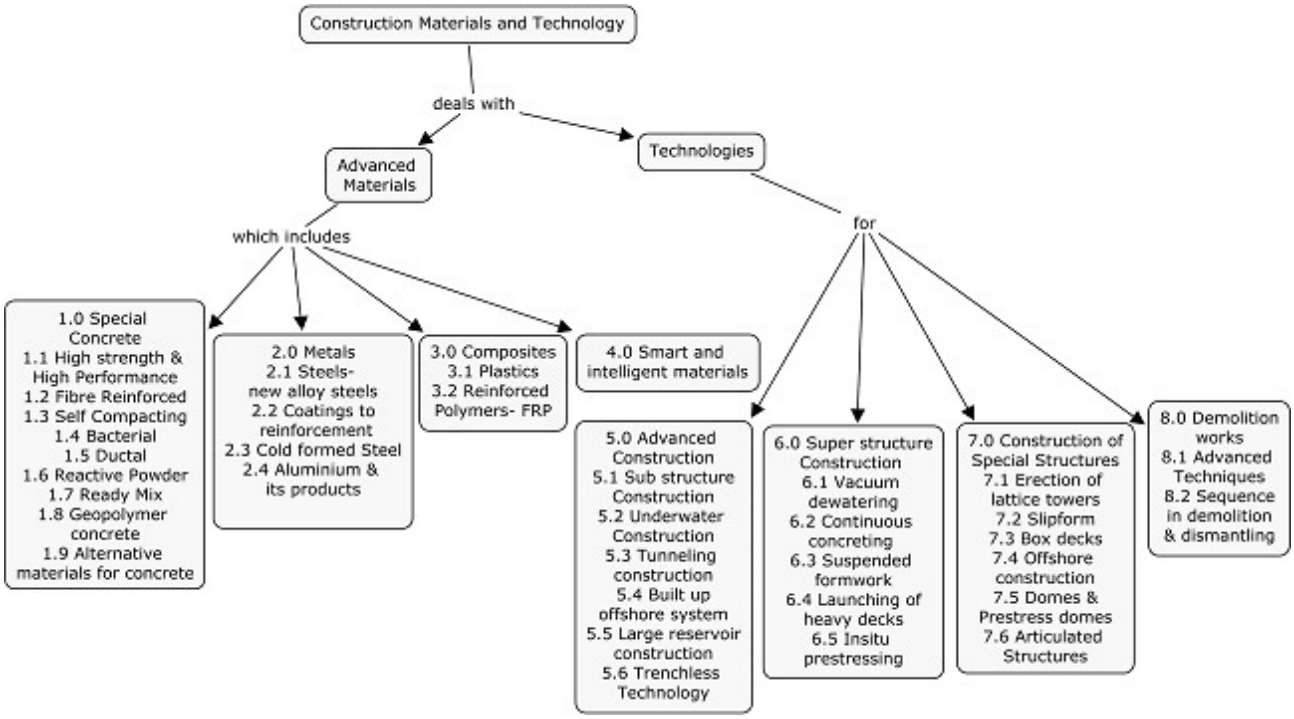
Understand:

1. Differentiated between ready mix concrete and conventional concrete
2. Define the term shoring and explain any one method of it by means of a neat sketch
3. Write notes on: slip form construction and prepacked concrete
4. Discuss the properties, manufacture and applications of FRC
5. Discuss the features of smart and intelligent materials mentioning its applications
6. Discuss the procedure of erection of articulated structures

Apply:

1. Recommend suitable formwork for cooling towers construction and justify your recommendation
2. What type of concreting method would you recommend for under water construction works? Why?
3. As an Infrastructure Engineer recommend a suitable concrete for reservoir construction? Provide suitable reasons for your selection
4. Suggest suitable sequence to be followed for demolition and dismantling of a distressed bridge
5. For a roof decking work for an industry what type of steel would you recommend? Justify?
6. For an old building under distress laid over a poor soil, what is the treatment material you would recommend? Why?

Concept Map



Course Content and Lecture Schedule

No.	Topic	No. of Lectures
	Advanced Materials	
1.0	**Special Concretes:** Concretes, Behaviour of concretes	
1.1	High Strength and High performance Concrete – manufacture, properties & applications	1
1.2	Fibre Reinforced Concrete– manufacture, properties & applications	1
1.3	Self Compacting Concrete – manufacture, properties & applications	1
1.4	Bacterial Concrete – manufacture, properties & applications	1
1.5	Ductal – manufacture, properties & applications	1
1.6	Reactive Powder concrete – manufacture, properties & applications	1
1.7	Ready Mix concrete – manufacture, properties & applications	1
1.8	Geopolymer concrete– manufacture, properties & applications	1
1.9	Alternative materials for concrete – manufacture, properties & applications	1

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 – properties & applications	1
2.4	aluminum and its products – properties & applications	1
3.0	**Composites:**	
3.1	Plastics - properties & applications	1
3.2	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	1
5.3	Tunneling techniques-cable anchoring and grouting-driving diaphragm walls, sheet piles	2
5.4	Laying operations for built up offshore system	1
5.5	Large reservoir construction	2
5.6	Trenchless technology	2
6.0	**Superstructure Construction for buildings:**	
6.1	Vacuum dewatering of concrete flooring- concrete paving technology	2
6.2	Techniques of construction for continuous concreting	2
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	2
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	2

	scrapers	
7.3	Bow string bridges, cable stayed bridges- launching and pushing of box decks	2
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.	2
8.0	**Demolition Techniques:**	
8.1	Advanced techniques of demolition	1
8.2	Sequence in demolition and dismantling operation	2
	Total Periods	**50**

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, Ready Mix concrete, geopolymer concrete, alternative materials for concrete. **Metals:** Steels –new alloy steels, coatings to reinforcement, Cold formed steel aluminum and its products – applications. **Composites:** Plastics – 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.

References:

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

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
IM13	3	1	0	4

IM13 Traffic Engineering and Transport Planning 3:1

Preamble

Reliable and efficient traffic engineering management and transport planning 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 transportation planning. Further, students can develop skills in the field of transport economics and will be exposed to computer applications in traffic engineering.

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

1. Identify various traffic engineering studies
2. Explain traffic flow and its characteristics
3. Design traffic facilities
4. Undertake efficient transportation planning measures
5. State the transport economics
6. Explore computer applications in traffic engineering and planning

Assessment Pattern

S. No.	Bloom's Category	Test 1	Test 2	Test 3/End - semester Examination
1.	Remember	20	20	20
2.	Understand	60	60	60
3.	Apply	20	20	20
4.	Analyze	-	-	-
5.	Evaluation	-	-	-
6.	Create	-	-	-

Course Level Learning Objectives

Remember

1. List the various human factors which are of importance to driver.
2. List out the different types of resistance offered by the vehicle while it is in motion.
3. Mention the various driver characteristics affecting traffic behaviour on roads.
4. Define Running speed and travel speed.
5. Define the terms Basic capacity and possible capacity.

6. Write the advantages of one way street.

Understand

1. Differentiate between space mean speed and time mean speed.
2. Explain the significance and scope of traffic engineering.
3. How does land use influence traffic generation?
4. What do you mean by signal coordination?
5. Distinguish between intersection and interchanges.
6. Describe the different methods of conducting Traffic volume studies. Mention the principle and application of the each.

Apply

1. If a vehicle is travelling at 50 kmph and coefficient of friction between the tyre and pavement is 0.30, calculate the braking distance.

2. The following data were obtained from the spot speed studies.

Suggest i) Speed limit for regulation

ii) Speed to check geometric design elements iii) Lower speed group causing congestion iv)Dispersion.

Speed range kmph	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of vehicles observed	20	45	75	95	290	420	210	155	85	40

3. Traffic flow in an urban section at the intersection of two highways in the design year are given below. The highways intersect at right angles and have a carriage way width of 16m.Design the rotary intersection using PCU value of car =1,commercial vehicle (com.v) =2.8 and scooter (SC)=0.75.

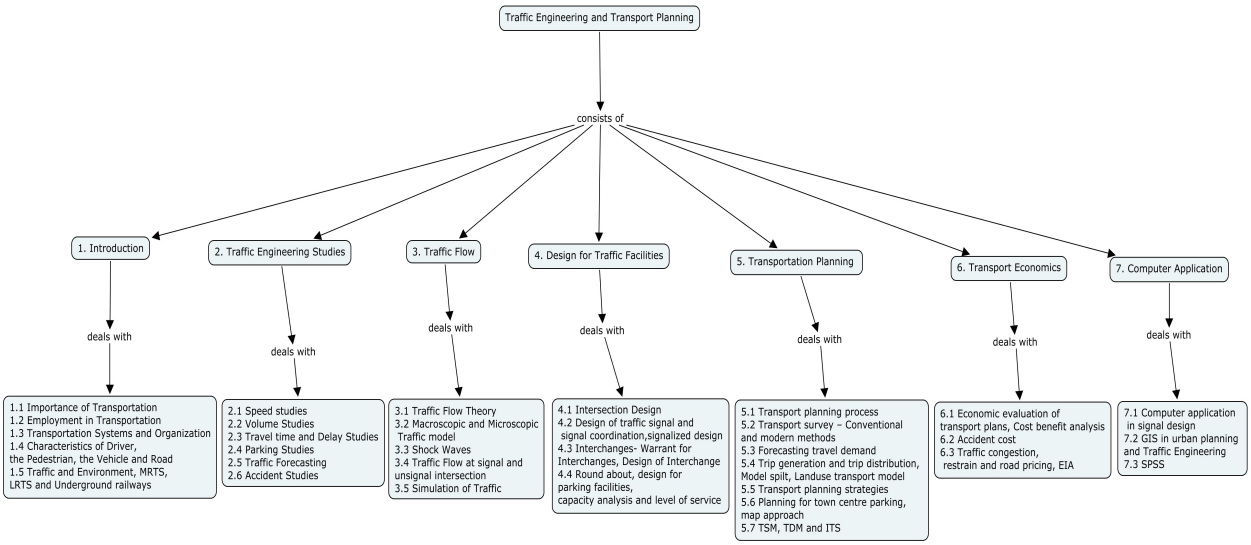
Approach	Left turning			Straight Ahead			Right Turning		
	Car	Com.V	SC	Car	Com.V	SC	Car	Com.V	SC
N	200	50	100	250	40	160	150	50	80
E	175	60	80	210	60	120	150	60	120
S	245	70	100	120	50	80	160	55	80
W	210	40	120	190	45	100	180	75	100

4. Draw neatly a rotary intersection where four roads meet and indicate the directions of traffic flow.

5. Describe the procedure of carrying out Travel Demand Management.

6. Describe the significance and advantages of Intelligence Transport system in Traffic Engineering.

Concept Map



Lecture Schedule

S.No.	Topic	No.of Lectures
1.	**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, the Pedestrian, the Vehicle and Road(Problems)	2
1.5	Traffic and Environment, MRTS, LRTS and Underground railways	2
2.	**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)	1
3.	**Traffic Flow**	
3.1	Introduction to Traffic Flow Theory	1
3.2	Macroscopic and Microscopic Traffic model	1
3.3	Shock Waves	1
3.4	Traffic Flow at signal and unsignal intersection	1
3.5	Simulation of Traffic(Concepts and problems)	2
4.	**Design for Traffic Facilities**	
4.1	Intersection Design	1
4.2	Design of traffic signal and signal coordination,signalized design	2
4.3	Interchanges - Warrant for Interchanges, Design of Interchange	2
4.4	Round about, design for parking facilities, capacity analysis and level of service(concepts and problems).	2
5.	**Transportation Planning**	
5.1	Transport planning process	1
5.2	Transport survey – Conventional and modern methods (Remote sensing, GIS and GPS techniques)	1
5.3	Forecasting travel demand	1
5.4	Trip generation and trip distribution, Model spilt, Landuse transport model	2
5.5	Transport planning strategies	1
5.6	Planning for town centre parking, map approach	1
5.7	TSM, TDM and ITS	2
6.	**Transport Economics**	
6.1	Economic evaluation of transport plans, Cost benefit analysis	1
6.2	Accident cost	2
6.3	Traffic congestion, restrain and road pricing, EIA	1
7.	**Computer Application**	
7.1	Computer application in signal design	1
7.2	GIS,SPSS in urban planning and Traffic Engineering	1
	Total	**40**

Syllabus

Introduction Importance of transportation – Employment in transportation – Tranportation systems and organisation. Characteristics of Driver, the pedestrian, the vehicle and road.(problems). Traffic and Environment, MRTS,LRTS and Underground railways. **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-Macroscopic and microscopic traffic model, shock waves, traffic flow at signal and unsignal intersection. Simulation of traffic. (concepts and problems)**Design For Traffic Facilities** Intersection design, Design of traffic signal and signal coordination. Interchanges – Warrant for interchanges, design of interchange –round about,design for parking facilities, capacity analysis and level of service.(concepts and problems)**Transportation Planning** Transport planning process – transport survey- Conventional and modern methods (Remote sensing, GIS and GPS techniques) – forecasting travel demand – trip generation and trip distribution, model split, land use transport model. Transport planning strategies. Planning for town centre parking, map approach- TSM, TDM and ITS.**Transport Economics** Economic evaluation of transport plans, Cost benefit analysis – accident cost – traffic congestion, restrain and road pricing, EIA.**Computer Application** Computer application in signal design, GIS in urban planning, traffic engineering and SPSS.

References

1. Kadiyali L.R, "Traffic Engineering and Transportation Planning" Khanna Publishers, Delhi, 2005.

2. Khanna SK and Justo CEG, "Highway Engineering", Nem Chand &Bros,. Roorkee,2010.

3. Brase/Brase "Understandable Statistics 3rd edition",D C Health and Company,Lexington, Massachusetts,Toronko,1987.

4. Jason C.yu, Tansportation 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. Partha Chakroborty and Animesh Das," Principle of Traffic Engineering",Prentice Hall of India,New Delhi,2003.

8. Flaherty,"Transportation Planning and Traffic Engineering",Elesevier India Pvt Ltd.,2006.

9. Mike Slinn, Peter Guest and Paul Matthews "Traffic Engineering Design Principles and Practice",Elesevier, 2006.

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
IM14	4	0	--	4

IM14 GEOTECHNIQUES FOR INFRASTRUCTURE 4:0

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 geotextiles. 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.

Competencies: At the end of the course the student will be able to.

1. Suggest appropriate construction methods for Rafts, Piles, Caissons and Diaphragm walls.
2. Suggest method of construction of Foundation for Transmission line Towers.
3. Suggest suitable Foundation Techniques for Expansive soils and Compressible soils.
4. Suggest suitable Drainage and Dewatering Techniques for the construction of Foundations.
5. Adopt safety measures during piling and construction of other deep foundations.
6. Suggest ground remediation work with the use of Geotextiles.

Assessment Pattern:

S.No.	**Bloom's Category**	**Test 1**	**Test 2**	**Test 3/End semester Examination**
1	Remember	20	20	20
2	Understand	30	30	30
3	Apply	0	0	0
4	Analyse	50	50	50
5	Evaluate	0	0	0
6	Create	0	0	0

Course level learning objectives:

Remember

1. Mention the different types of Raft foundations.
2. What are Diaphragm walls?
3. Define Pile group efficiency.
4. What are the problems associated with soft soils?
5. What are geotextiles?
6. Define sensitivity.

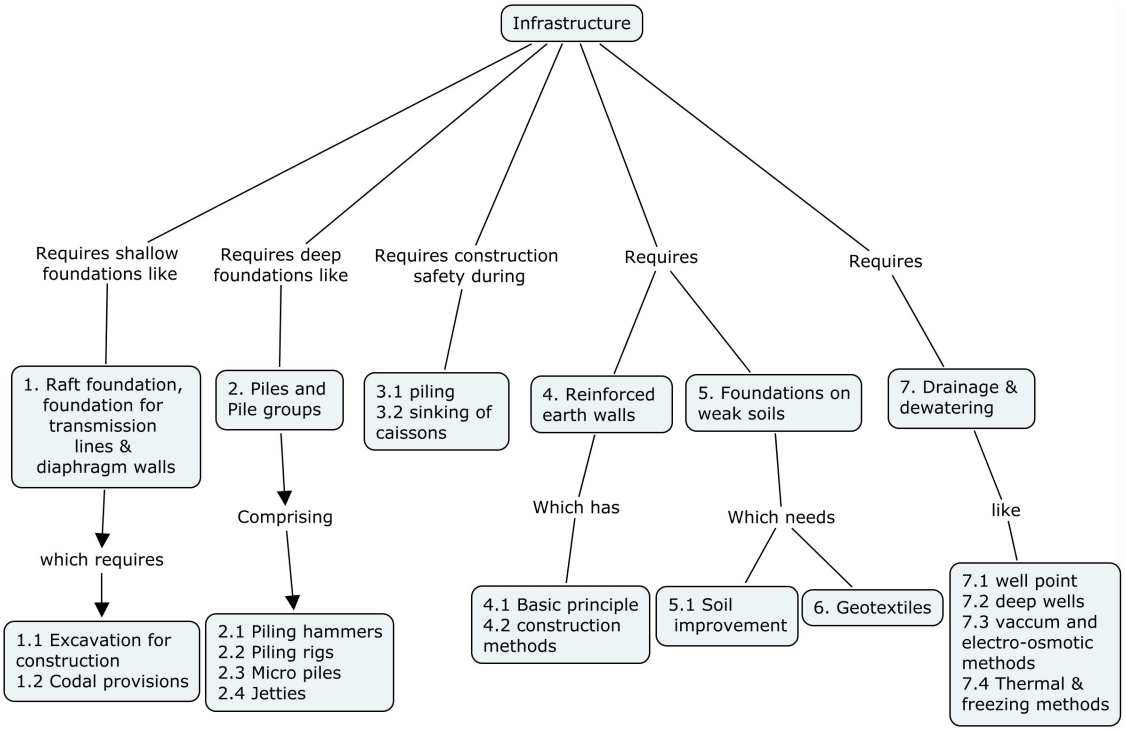
Understand

1. Explain the concept of Piled raft.
2. Discuss the construction procedure of Micro piles.
3. Explain the mechanism of reinforced earth walls.
4. Describe thermal and freezing methods of soil stabilization.
5. Explain the safety measures to be followed during pile driving operations.
6. Write a note on zone of soil volume change in expansive soils.

Analyse

1. Discuss the method of installation of a driven pile group.
2. Enumerate the safety measures adopted during sinking of caissons.
3. Compare the preloading and dynamic compaction methods of soil stabilization.
4. Discuss the applications of geotextiles in ground improvement.
5. Compare deep wells and vacuum methods of dewatering.
6. Compare the various types of hammers used for Pile driving operations.

Concept Map:



Course content and Lecture schedule:

No	Topic	No. of Lectures
1.	**CONSTRUCTION OF SHALLOW FOUNDATIONS**	
1.1	Excavations for Foundations in soft soils - recommendations	3
1.2	Types of Raft - Construction of Raft Foundations	3
1.3	Foundations for Transmission line towers and poles – Construction of Diaphragm walls	3
1.4	Codal provisions	2
2.	**CONSTRUCTION OF DEEP FOUNDATIONS**	
2.1	Selection of appropriate type of Pile – Piling rig – Pile driving hammers	3
2.2	Construction aspects of bored and driven Piles – Micro Piles – Pile groups	3
2.3	Berthing structures and Jetties – Codal provisions	3

3.	**CONSTRUCTION SAFETY**	
3.1	Safety measures during piling – sinking of Caissons	3
4.	**EARTH REINFORCEMENT**	
4.1	Earth reinforcement – Principles and basic mechanism of reinforced earth	2
4.2	Construction of reinforced earth retaining walls	1
5.	**FOUNDATIONS ON WEAK SOILS**	
5.1	Soil improvement for compressible and expansive soils	3
5.2	Foundation Techniques for compressible and expansive soils.	3
6.	**GEOTEXTILES**	
6.1	Synthetic and natural fiber based Geotextiles	1
6.2	Application of Geotextiles - Filtration, drainage	2
6.3	Separation - erosion control	2
7.	**DRAINAGE AND DEWATERING METHODS**	
7.1	Drainage - Ground Water lowering by Well points, Deep wells	3
7.2	Vacuum and Electro-osmotic methods	3
7.3	Design steps for Dewatering system – capacity of pumps required	2
7.4	Types of Drains and their components.	2
7.5	Stabilization by thermal and freezing techniques	2
7.6	Case studies	1
	Total	50

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 – Codal provisions. **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- Design steps for Dewatering system – capacity of pumps required – Types of Drains and their components – Stabilization by thermal and freezing techniques – Case studies.

Text Books:

1. Hans – George Kempfert & Berhane Gebreselassie., Excavation And Foundations in soft soils, Springer.
2. M.J.Tomlinson., Pile Design and Construction Practice, Fourth Edition, E & FN SPON an imprint of Chapman & Hall.
3. Das, B.M., Principles of Foundation Engineering, Fourth Edition, PWS Publishing, 1999.
4. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Ltd., New Delhi, 2007.

Course Designer:

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Sub Code	Lectures	Tutorial	Practical	Credit
IM15	3	1	0	4

IM15 Quantitative Methods in Management 3:1

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.

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

1. Understand the phases of Operations Research study
2. Formulate problems mathematically using the concept of Linear Programming (LP)
3. Solve LP problems by graphical method, and identify special cases in obtained solution
4. Solve LP problems by Simplex method and Artificial variable techniques, and identify special cases in the solutions and Understand the concept of duality
5. Solve transportation, assignment and traveling salesman problems
6. Apply Dynamic Programming to shortest route problems, capital budgeting problems and LPP
7. Apply game and decision theories to problems
8. Perform Monte-Carlo simulation of Civil engineering systems

Assessment Pattern

S. No.	**Bloom's Category**	**Test 1**	**Test 2**	**End -semester Examination**
1.	Remember	20	20	20
2.	Understand	20	20	20
3.	Apply	60	60	60
4.	Analyze	0	0	0
5.	Evaluation	0	0	0
6.	Create	0	0	0

Course Level Learning Objectives:

Remember:

1. What is the purpose of Slack variables in Simplex method?

2. Write the standard form of a LPP
3. What is meant by a system? Give examples
4. Define the term optimization with examples
5. Write the objective of transportation problem
6. Write the aim of traveling salesman problem
7. What is simulation? Write its purpose

Understand:

1. Discuss the various types of OR model. Write the principles of modeling OR problems
2. Explain how assignment problems can be treated as a particular case of Transportation problem?
3. Discuss the special cases in Simplex method of solution of LPP
4. List the various criteria in which decision making can be done
5. Discuss the most frequent causes of simulation analysis failure and how to avoid them
6. Distinguish between the solutions derived from Simulation models and that derived from analytical models

Apply:

1. A construction company has alternatives of building 2, 3 and 4 bedroom houses. The company wishes to establish the number of each type if any that will maximize the profit subject to the following conditions:

   i) the total budget is limited to Rs. 40×10^7

   ii) the total number of units must be atleast 300 for the venture to be economically feasible

   iii) the maximum % of each type based on market analysis is as follows:

   - 2 bedroom houses = 55% of total
   - 3 bedroom houses = 30% of total
   - 3 bedroom houses = 15% of total

   iv) the building costs and profits by sales are as follows:

Unit	Cost (Rs.)	Profit (Rs.)
2 bedroom houses	8,00,000	80,000
3 bedroom houses	10,00,000	1,25,000
3 bedroom houses	12,00,000	1,50,000

   Formulate the problem as a LPP

2. Solve the following LPP by 2–phase technique.

   Minimize $Z = -3X_1+X_2$

   Subject to: $2X_1 + X_2 \geq 2$; $X_1 + 3X_2 \leq 2$; $X_2 \leq 4$; & $X_1, X_2 \geq 0$.

3. Using Simplex Method

   Maximize $Z= X_1+2X_2-X_3$

   Subject to: $2X_1+X_2+X_3 \leq 14$, $4X_1+2X_2+3X_3 \leq 28$, $2X_1+5X_2+5X_3 \leq 30$,

   $X_1 \geq 0$; $X_2 \geq 0$; X_3 is unrestricted in sign

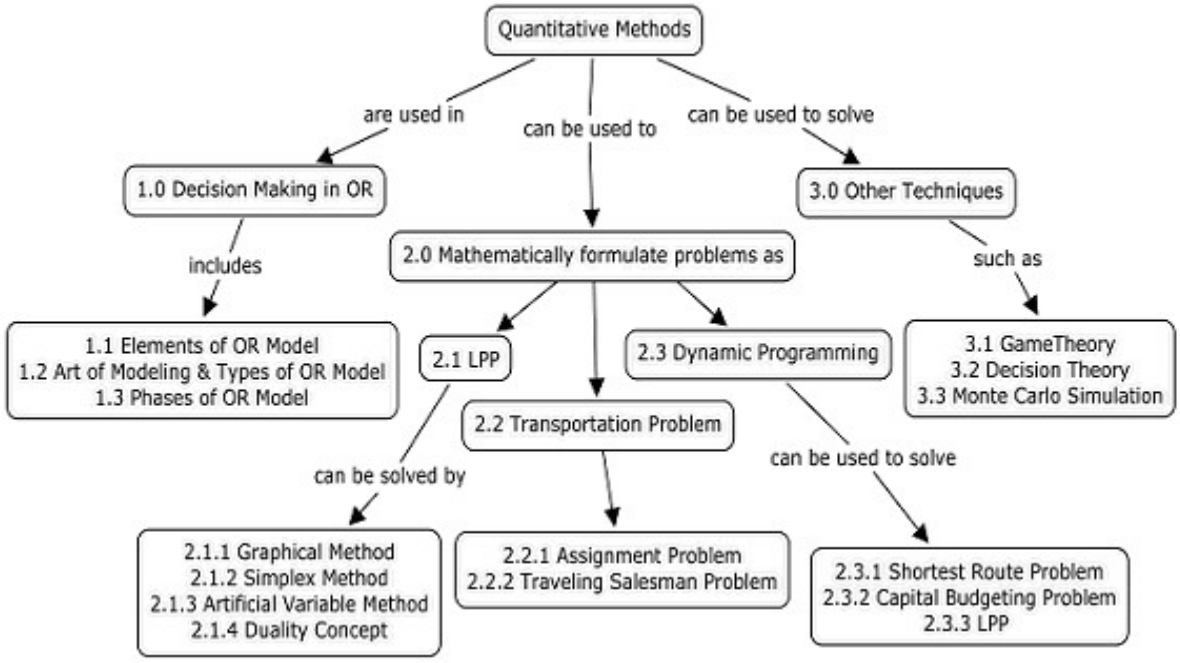
4. A construction company has 4 jobs and 4 labourers to do it. Each labourers can handle any job. The service in hours of each job when manned by each labourer is given below. How should the labourers be allocated to appropriate jobs so as to minimize the service time? Each labourers must handle only one job.

Jobs	Labourers A	B	C	D
W	41	72	39	52
X	22	29	49	65
Y	27	39	60	51
Z	45	5	48	52

5. A tile manufacturing company manufactures two types of flooring tiles, regular and deluxe. The product is prepared in two plants, regular tiles are manufactured in Plant A and deluxe in plant B. Due to limitations in production capacities of A and B, the daily production is limited to not more than 900 regular tiles and 600 deluxe tiles. The product of both the types of tiles requires chips of a particular variety which is in short supply and limited to 525 units/day. The production of a regular tile requires 5 units of chips and deluxe tiles require 8 units of chips. Company has 160 hours of labour. To manufacture 10 regular tiles it requires 2.5 hours and 20 deluxe tiles 10 hours of labour. The profit for 100 regular tiles is Rs.50/- and 25 deluxe tiles is Rs.75/-. Formulate the LPP.
6. Use Dynamic Programming and solve the following short route problem and determine the shortest distance between cities 1 and 10

City (i –j)	1-2	1-3	2-4	3-4	2-5	3-6	4-8	4-9	4-7	5-7	6-7	6-9	7-10	5-8	8-10	9-10
Dist. miles	2	2	3	5	2	4	7	8	2	1	9	2	6	7	2	3

Concept Map



Course Content and Lecture Schedule

No.	Topic	No. of Lectures
1.0	**Decision Making in OR**	
1.1	Optimization – meaning. Elements of OR Model	2
1.2	Art of modeling and types of OR models	2
1.3	Phases of OR model	1
2.0	**Mathematical Formulation of OR**	
2.1	**Linear Programming Problem-** Definition and properties of Linear Programming Problem, Standard form	2
2.1.1	Graphical solution of two variable problems- Special cases	2
2.1.2	Simplex method - computational procedure & Problems	2
2.1.3	Artificial variable Technique– M technique- procedure & problems	2

2.1.3	Artificial variable Technique -Two phase technique- procedure & problems	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	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	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	3
2.3.2	Capital budgeting problem – Computational procedure – Problems	2
2.3.3	Solution of Linear Programming Problem by Dynamic Programming – problem	2
3.0	**Other techniques**	
3.1	Game theory – procedure and problems	2
3.2	Decision Theory - procedure and problems	3
3.3	Simulation – Monte Carlo simulation – brief concept	3
	Total Periods	**40**

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-2003

2. S.S. Rao, "Optimization- Theory and Applications", New Age International (P) Ltd., Publishers 2001

1. P.D. Charbra, "Computer Oriented Optimization Techniques for Traffic and Transportation systems", Khanna Publishers

2. N. Krishna Raju and K.U. Muthu, "Numerical Methods in Engineering Problems", McMilan India Ltd., 1996

Course Designers

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Sub Code	Lectures	Tutorial	Practical	Credit
IM16	4	0	0	4

IM16 Urban Environmental Management 4:0

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 and its management. Safe collection system for generated wastewater and solid waste and their safe disposal beyond urban limit to be free from pollution is also addressed in the course work.

Competencies

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

1. Understand and explain the various urban environmental issues.
2. Plan and execute various management aspects of urban water resources.
3. Plan and design a water supply system for a city.
4. Estimate the quantity of generation of wastewater and design collection system for the same.
5. Identify the source of generation of solid waste, its collection methodology and dispose safely.

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	Test 3/End semester Examination
1	Remember	20	20	20
2	Understand	50	50	50
3	Apply	30	30	30
4	Analyse	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives:

Remember

1. Define: Master Plan
2. List the software's available for environmental engineering.
3. Define. Urban Water Cycle

4. Define: Sustainable Management
5. Define: Recycling and Reuse

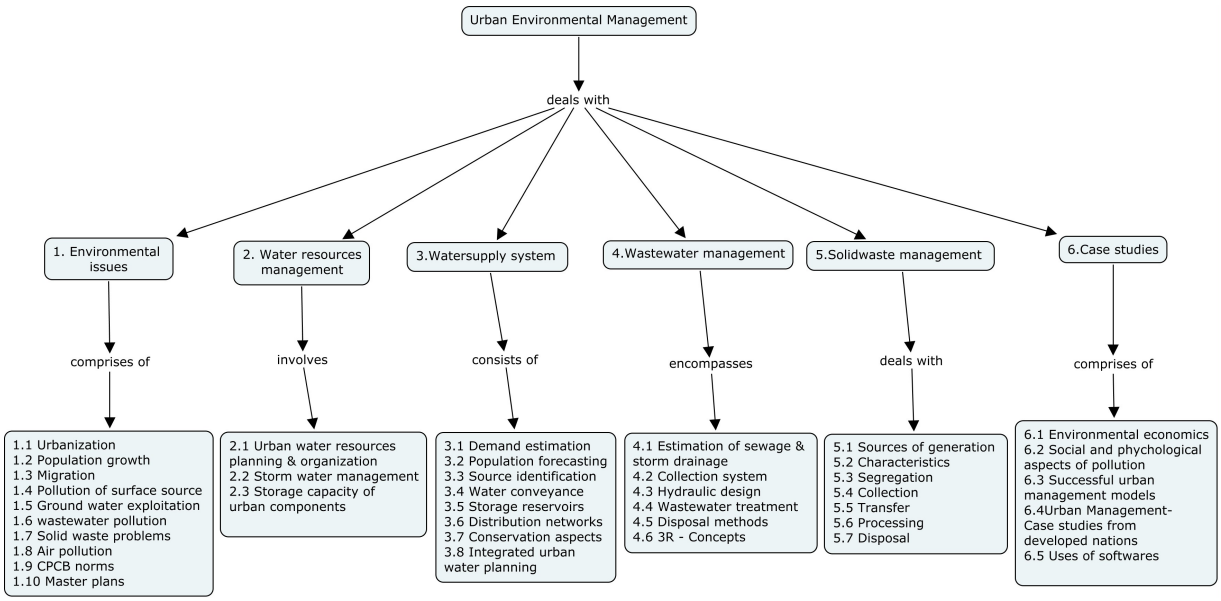
Understand

1. Differentiate Point and Non Point source of pollution with examples
2. How temple tanks can be used for Rain water Harvesting?
3. Why social awareness is necessary for water management?
4. List the advantages of SCS curve method for the runoff calculation.
5. Write the principles of Ecopsychology
6. How fish ponds are better than duckweed ponds. justify your answer.
7. Write significance of management of urban environment in today's context.

Apply

1. Write the process of converting the urban tank into a percolation pond and discuss why the urban tank is to be converted into a pond.
2. Suggest and prioritize Rain water harvesting methods for a city with rainfall of 900 mm and open area of 22%.
3. Write the importance of Urban Agriculture in the context of pollution prevention.
4. Assume the 20 years of rainfall for a city with population of 1 Million and chart out an "Integrated Water Plan" after considering all the available resources.
5. Estimate the population of the city in the year 2031, the details are as follows: 2001- 9.5 lakhs , 1991- 8.2 lakhs, 1981- 6.5 lakhs by any two methods.

Concept map



Course content and Lecture schedule

No	Topic	No. of Lectures
1.	**Environmental issues**	
1.1	Urbanization	1
1.2	Population growth scenario	1
1.3	migration	1
1.4	Pollution of surface water resources	1
1.5	ground water exploitation– rivers, tanks, channels	1
1.6	Wastewater – characteristics	1
1.7	Solid waste problem	1
1.8	air pollution	1
1.9	CPCB norms	1
1.10	Urban master plans – Planning and organizational aspects	2
2.	**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 –	3
3.	**Urban water supply**	
3.1	Demand estimation	1
3.2	population forecasting	1
3.3	source identification	1
3.4	water conveyance	1
3.5	storage reservoirs–fixing storage capacity	2
3.6	Distribution network – types – analysis – computer applications	2
3.7	Conservation techniques	1
3.8	Integrated urban water planning	1
4.	**Urban wastewater management**	
4.1	Sewage generation – storm drainage estimation – industry contribution	2
4.2	wastewater collection system – separate and combined system	2
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.	**Municipal solid waste management**	
5.1	Sources of solid waste	1
5.2	Characteristics of solid waste	1
5.3	rate of generation	1
5.4	segregation at source	1
5.5	collection of solid waste	1
5.6	methods of collection – route analysis – transfer and transfer stations	2
5.7	processing	1
5.8	disposal of solid waste	1
6.	**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	2
6.5	Softwares	1
	Total	**50**

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.

Reference Books

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

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Sub Code	Lectures	Tutorial	Practical	Credit
IM17	0	0	3	1

IM17 CONCRETE TECHNOLOGY & STRUCTURAL ENGINEERING LABORATORY 0:1
(Common to J17)

1. Design of concrete mix by IS method and casting
2. Test on fresh concrete
   (a) Slump cone test
   (b) Compaction Factor test
3. Test on hardened concrete- Study of stress and strain characteristics, and determination of Young's modulus- Split Tensile Test
4. a)Test on hardened concrete using Non - Destructive Testing Techniques
   i. Ultrasonic method
   ii. Rebound Hammer method
   iii. Comparison of destructive test results with the NDT results
5. Determination of material fringe value using Transmission Polariscope
6. Determination of suitability of water for concreting and curing
7. Soil analysis for Safe Bearing Capacity determination
8. Determination of tensile strength of steel plates by coupon test
9. Study of moment curvature characteristics of RCC specimens
10. Calibration of Equipments and interpretation of results
11. Determination of Endurance Limit using Fatigue testing machine
12. Monitoring of corrosion in Reinforced concrete and steel
13. Study of steel frame under seismic effect
14. Design of rigid and flexible pavements using codal provisions
15. Determination of roughness of road surface using Merlin equipment

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