CURRICULUM AND DETAILED SYLLABI

FOR

M.E DEGREE (CONSTRUCTION ENGINEERING AND MANAGEMENT) PROGRAMME

FIRST TO FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2022-2023 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institution affiliated to Anna University)

MADURAI – 625 015

Approved in 64rd Academic Council Meeting on 11.01.2023

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 Construction Engineering & Management programme:

PEO 1) Graduates will apply technical and managerial skills to formulate strategies to achieve project 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 Construction Engineering & Management programme are as follows:

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 considerisation 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. (Construction Engineering and Management)

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

Department of Civil Engineering

M.E Construction Engineering and Management - Schedule of courses

Semester	Theory Courses					Theory cum Practical	Laboratory	Project	Credits
	1	2	3	4	5	6	7	8	
1st	22CM110 Applied Statistics and Optimization (FC) (3 credits)	22CM120 Modern Construction Materials (PC1) (3 credits)	22CM130 Construction Equipment and Management (PC2) (3 credits)	22CM140 Quantitative Methods in Management (PC3) (3 credits)	22CMPX0 (PE1) (3 credits)	22CM160 Project Formulation and Implementation (PC4) (3 Credits)	22CM170 Advanced Construction Engineering Laboratory (Lab1) (2 credits – 4 hours)	---	20
2nd	22CMPX0 (PE2) (3 credits)	22CMPX0 (PE3) (3 credits)	18PGPX0 Open Elective (2 credits)	18PG250 Common Core – (2 credits)	---	22CM260 Project Planning and Control (PC5) (3 credits)	22CM270 Building Information Modelling Lab (Lab2) (2 credits – 4 hours)	22CM280 Mini Project (2 credits)	17
3rd	22CMPX0 (PE4) (3 credits)	22CMPX0 (PE5) (3 credits)	---	---	---	---	---	22CM380 Dissertation Phase I (10 credits)	16
4th	---	---	---	---	---	---	---	22CM480 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 (Construction Engineering and Management) Program

COURSES OF STUDY

(For the candidates admitted from 2022-2023 onwards)

FIRST SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CM110	Applied Statistics and Optimization	FC	2	1	0	3
22CM120	Modern Construction Materials	PC	3	0	0	3
22CM130	Construction Equipment and Management	PC	3	0	0	3
22CM140	Quantitative Methods in Management	PC	2	1	0	3
22CM160	Project Formulation and Implementation	PC	2	0	2	3
22CMPX0	Program Elective – I	PE	3	0	0	3
PRACTICAL						
22CM170	Advanced Construction Engineering Laboratory	PC	0	0	4	2
Total			**15**	**2**	**6**	**20**

SECOND SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
THEORY						
22CMPX0	Program Elective – II	PE	2	1	0	3
22CMPX0	Program Elective – III	PE	2	1	0	3
22CMPX0	Open Elective	PE	2	0	0	2
18PG250	Common Core	PC	2	0	0	2
22CM260	Project Planning and Control	PC	2	0	2	3
PRACTICAL						
22CM270	Building Information Modeling Lab	PC	0	0	4	2
22CM280	Mini Project	PC	0	0	4	2
Total			**10**	**2**	**10**	**17**

THIRD SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
THEORY						
22CMPX0	Programme Elective – IV	PE	3	0	0	3
22CMPX0	Programme Elective – V	PE	3	0	0	3
PRACTICAL						
22CM380	Dissertation Phase-I	PC	0	0	20	10
Total			**6**	**0**	**20**	**16**

FOURTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
22CM480	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

PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

For all the theory courses, laboratory courses, theory courses with laboratory component and project work the continuous assessment shall be awarded as per the procedure given below:

THEORY COURSES

Two assessments each carrying 100 marks shall be conducted during the semester by the Department / College concerned. The total marks obtained in all assessments put together out of 200, shall be proportionately reduced for 40 marks and rounded to the nearest integer (This also implies equal weightage to the two assessments).

Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project / any other experiential Learning	Written Test	Individual Assignment / Case Study / Seminar / Mini Project / any other experiential Learning	Written Test	**Total** Internal Assessment
40	60	40	60	200*

**The weighted average shall be converted into 40 marks for internal Assessment.*

A minimum of two internal assessments will be conducted as a part of continuous assessment. Each internal assessment is to be conducted for 100 marks and will have to be distributed in two parts viz., Individual Assignment/Case study/Seminar/Mini project and Test with each having a weightage of 40% and 60% respectively. The tests shall be in written mode. The total internal assessment marks of 200 shall be converted into a maximum of 40 marks and rounded to the nearest integer.

LABORATORY COURSES

The maximum marks for Internal Assessment shall be 60 marks in case of practical courses. Every practical exercise / experiment shall be evaluated based on conduct of experiment / exercise and records are to be maintained. There shall be at least one test. The criteria for arriving at the Internal Assessment marks of 60 is as follows: 75 marks shall be awarded for successful completion of all the prescribed experiments done in the Laboratory and 25 marks for the test. The total mark shall be converted into a maximum of 60 marks and rounded to the nearest integer.

Internal Assessment (100 Marks)*	
Evaluation of Laboratory Observation, Record	Test
75	25

** Internal assessment marks shall be converted into 60 marks*

THEORY COURSES WITH LABORATORY COMPONENT / LABORATORY COURSES WITH THEORY COMPONENT

Weightage of internal assessment and end semester examination marks will be 50% each. The distribution of marks for the theory and laboratory components in the internal assessments and end semester examination for different types of courses are provided in the table.

L	***T***	***P***	***C***	***Internal***		***End semester examination***
				Assessment 1	***Assessment 2***	
1	*0*	*4*	*3*	*Laboratory (25%)*	*Theory (25%)*	*Laboratory only (50%)*
1	*0*	*2*	*2*	*Laboratory (25%)*	*Theory (25%)*	*Laboratory only (50%)*
2	*0*	*2*	*3*	*Theory (25%)*	*Laboratory (25%)*	*Theory (25%)* *Laboratory (25%)*
3	*0*	*2*	*4*	*Theory (25%)*	*Laboratory (25%)*	*Theory (35%)* *Laboratory (15%)*
2	*0*	*4*	*4*	*Theory (25%)*	*Laboratory (25%)*	*Theory (15%)* *Laboratory (35%)*

The procedure for the conduct of internal assessments for theory and laboratory components shall be as per the clause 12.1 and 12.2 respectively*.

The weighted average shall be converted into 50 marks for internal Assessment.

* Autonomous Colleges may adopt Theory courses with Laboratory component and Laboratory courses with Theory component with different L T P C formats and the weightage of marks for Theory and Laboratory components may be fixed in proportion to lecture and practical contact periods. However, the weightage for internal and end semester examination marks will remain as 50% each.

PROJECT WORK / INTERNSHIP AND LABORATORY COURSES

For the Project Work / Internship and Laboratory Courses fixed grading procedure shall be followed.

PASSING REQUIREMENTS

A student who secures not less than 50% of total marks prescribed for the course [Internal Assessment + End semester University Examinations] with a minimum of 45% of the marks prescribed for the end-semester University Examination, shall be declared to have passed the course and acquired the relevant number of credits. This is applicable for both theory and laboratory courses (including project work).

If a student fails to secure a pass in a theory course / laboratory course (except electives), the student shall register and appear only for the end semester examination in the subsequent semester. In such case, the internal assessment marks obtained by the student in the first appearance shall be retained and considered valid for all subsequent attempts till the student secures a pass. However, from the third attempt onwards if a student fails to obtain pass marks (IA + End Semester Examination), then the student shall be declared to have passed the examination if he/she secures a minimum of 50% marks prescribed for the University end semester examinations alone.

AWARD OF LETTER GRADES

The award of letter grades will be decided based on relative grading principle. The relative grading is applicable to ONLY those students who have passed the examination as per the passing requirements enumerated above. For those students who have not passed the examination, Reappearance (U) shall be awarded as shown in the below Table.

For those students who have passed the course, the relative grading shall be done. The marks of those students who have passed only shall be inputted in the software developed for relative grading. The evolved relative grading method normalizes the results data using the BOX-COX transformation method and computes the grade range for each course separately and awards the grade to each student. For a given course, if the students' strength is greater than 30, the relative grading method shall be adopted. However, if the students' strength is less than or equal to 30 then the fixed grading shall be followed with the grade range as specified below.

O	**A+**	**A**	**B+**	**B**	**C**	***U***
91 - 100	81 - 90	71 - 80	61 - 70	56 - 60	50 – 55	< 50

The performance of a student shall be reported using letter grades, each carrying certain points as detailed below:

Letter Grade	**Grade Points***
O (Outstanding)	**10**
A + (Excellent)	**9**
A (Very Good)	**8**
B + (Good)	**7**
B (Average)	**6**
C (Satisfactory)	**5**
U (Re-appearance)	**0**
SA (Shortage of Attendance)	**-**
WD (Withdrawal)	**-**

A student is deemed to have passed and acquired the corresponding credits in a particular course if he/she obtains any one of the following grades: "O", "A+", "A", "B+","B", "C".

'SA' denotes shortage of attendance and hence prevented from writing the end semester examinations. 'SA' will appear only in the result sheet.

"U" denotes that the student has failed to pass in that course. "**WD**" denotes **withdrawal** from the exam for the particular course. The grades U and WD will figure both in the Grade Sheet as well as in the Result Sheet. In both cases, the student has to appear for the End Semester Examinations.

If the grade U is given to **Theory Courses/ Laboratory Courses it is not required to satisfy the** attendance requirements, but has to appear for the end semester examination and fulfil the passing requirements to earn a pass in the respective courses.

If the grade U is given to **EEC (Employability Enhancement Course) (except Project Work), which are evaluated only through internal assessment,** the student shall register for the course again in the subsequent semester, fulfill the passing requirements to earn pass in the course. However, attendance requirement need not be satisfied.

CLASSIFICATION OF THE DEGREE AWARDED FIRST CLASS WITH DISTINCTION

A student who satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction:**

- Should have passed the examination in all the courses of all the eight semesters (10 Semesters in case of Mechanical (Sandwich) and 6 semesters in the case of Lateral Entry) in the student's First Appearance within **five** years (S ix years in the case of Mechanical (Sandwich) and Four years in the case of Lateral Entry). Withdrawal from examination will not be considered as an appearance.
- Should have secured a CGPA of not less than **8.50**.
- One year authorized break of study (if availed of) is included in the five years (Six years in the case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class with Distinction.
- Should NOT have been prevented from writing end semester examination due to lack of attendance in any semester.

FIRST CLASS:

A student who satisfies the following conditions shall be declared to have passed the examination in **First class:**

- Should have passed the examination in all the courses of all eight semesters (10 Semesters in case of Mechanical (Sandwich) and 6 semesters in the case of Lateral Entry) **within five years**. (Six years in case of Mechanical (Sandwich) and Four years in the case of Lateral Entry).
- One year authorized break of study (if availed of) or prevention from writing the End Semester examination due to lack of attendance (if applicable) is included in the duration of five years (Six years in case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class.
- Should have secured a CGPA of not less than **6.50.**

SECOND CLASS:

All other students who qualify for the award of the degree shall be declared to have passed the examination in **Second Class**.

The corresponding specific changes are to be made to B.Arch. / M.Arch. / M.Plan. / MBA / M.Sc.(5years).

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

M.E Degree (Construction Engineering and Management) Program

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 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	22CM110	Applied Statistics and Optimization	3	40	60	100	27	50
2	22CM120	Modern Construction Materials	3	40	60	100	27	50
3	22CM130	Construction Equipment and Management	3	40	60	100	27	50
4	22CM140	Quantitative Methods in Management	3	40	60	100	27	50
THEORY CUM PRACTICAL								
5	22CM160	Project Formulation and Implementation	3	50	50	100	22.5	50
PRACTICAL								
7	22CM170	Advanced Construction Engineering Laboratory	3	60	40	100	18	50

SECOND 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	22CMPX0	Program Elective – II	3	40	60	100	27	50
2	22CMPX0	Program Elective – III	3	40	60	100	27	50
3	18PG250	Common Core	3	40	60	100	27	50
4	18PGPX0	Open Elective	3	40	60	100	27	50
THEORY CUM PRACTICAL								
5	22CM260	Project Planning and Control	3	50	50	100	22.5	50
PRACTICAL								
6	22CM270	Building Information Modeling Lab	3	60	40	100	18	50
7	22CM280	Mini Project	-	50	50	100	22.5	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	22CMPX0	Programme Elective – IV	3	40	60	100	27	50
2	22CMPX0	Programme Elective – V	3	40	60	100	27	50
PRACTICAL								
3	22CM380	Dissertation Phase-I	-	50	50	100	22.5	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	22CM480	Dissertation Phase-II	-	50	50	100	25	50

* 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	22CMPA0	CONTRACTS AND ARBITRATION
2	22CMPB0	STRATEGIC PLANNING FOR CONSTRUCTION SECTORS
3	22CMPC0	MANAGEMENT OF HUMAN RESOURCE IN CONSTRUCTION
4	22CMPD0	ADVANCED CONCRETE TECHNOLOGY
5	22CMPE0	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT
6	22CMPF0	REPAIR & REHABILITATION OF STRUCTURES
7	22CMPG0	FINANCE MANAGEMENT IN CONSTRUCTION
8	22CMPH0	SUSTAINABLE CONSTRUCTION
9	22CMPJ0	MANAGEMENT INFORMATION SYSTEM
10	22CMPK0	DESIGN OF ENERGY EFFICIENT BUILDINGS
11	22CMPL0	ORGANIZATIONAL BEHAVIOUR
12	22CMPM0	LEAN CONSTRUCTION
13	22CMPN0	AUTOMATION IN CONSTRUCTION
14	22CMPP0	COMPUTER APPLICATION IN CONSTRUCTION ENGINEERING AND PLANNING
15	22CMPQ0	SUPPLY CHAIN MANAGEMENT & LOGISTICS IN CONSTRUCTION
16	22CMPR0	PROJECT SAFETY MANAGEMENT
17	22CMPS0	QUALITY CONTROL AND QUALITY ASSURANCE
18	22CMPT0	SHORING, SCAFFOLDING AND FORMWORK
19	22CMPU0	ADVANCED CONSTRUCTION TECHNIQUES
20	22CMPV0	MATERIAL PROCUREMENT AND MANAGEMENT

LIST OF OPEN ELECTIVES

Sl.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

Sl.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

22CM110	APPLIED STATISTICS AND OPTIMIZATION	Category	L	T	P	Credit
		FC	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	Course Outcomes Statements	Bloom's Level
CO1	Calculate the value which relates the dependent variable to one or more independent variables.	Apply
CO2	State a statistical inference from information contained in random samples about the populations from which the samples were obtained	Understand
CO3	Estimate the characteristic of the population with degree of confidence from the random sample.	Apply
CO4	Determine the most reliable results of the population based on all the information available in a sample using non-parametric methods	Apply
CO5	Calculate the experimental error and hence to control the extraneous variables involved in the experiment	Apply
CO6	Determine the optimum values of unconstrained optimization problems using search methods	Apply

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	
Remember	10	10	10
Understand	20	20	20
Apply	70	70	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Multiple Correlations.
2. If $x_1, x_2, \ldots x_n$ 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 $\frac{(\tau - 1)}{n(n-1)}$ is an unbiased estimate of θ^2 where $\tau = \sum_{i=1}^{n} x_i$.
3. Calculate the M.L.E of the parameter of the population having the density function $f(x, y) = \frac{2}{\alpha^2}(\alpha - x)$, 0<x<i for a sample of unit size (single sample) and also Show that the estimate is biased.

Course Outcome 2 (CO2):

1. Define one tailed and two–tailed tests.
2. 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.
3. 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 areasthan in urban areas? Use Yate's Correction for continuity.

Course Outcome 3 (CO3):

1. 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.

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

2. 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.

3. Identify whether the sample having the values 63, 63,64,55,66,69,70,70 and 71 has been chosen from a population with mean of 65 at 5% level of significance.

Course Outcome 4 (CO4):

1. The following are the number of minutes it took a sample of 15 men and 12 womento 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 $\alpha = 0.05$ hypothesis that the two samples come from identical population.

2. The following are the number of misprints counted on pages selected at random fromthe 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.

3. The following arrangement indicates whether sixty consecutive care which went by the tollbooth 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 LO 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$\alpha = 0.05$.

Course Outcome 5 (CO5):

1. 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.

2. 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 theburners.

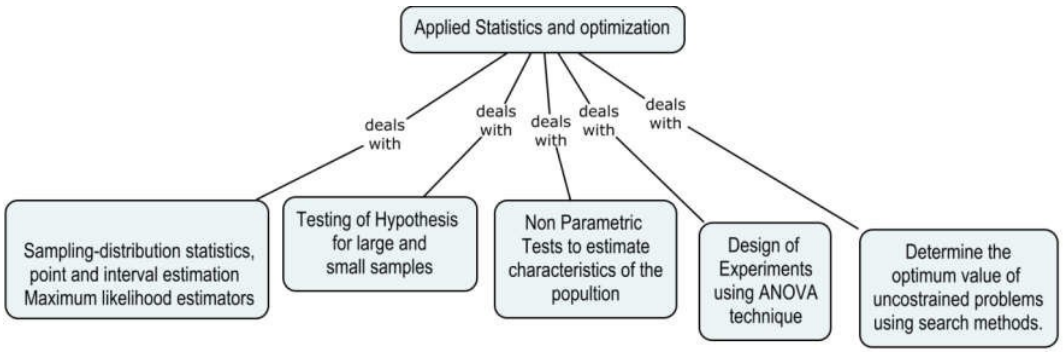
3. The following table shows the lives in hours of four brands of electric lamps brand.
A: 1610 1610 1650 1680 1700 1720 1720 1800
B: 1580 1640 1640 1700 1750
C: 1460 1550 1600 1620 1640 1660 1740 1820
D: 1510 1520 1530 1570 1600 1680.

Perform an analysis of variance to test the homogeneity of the mean lives of the fourbrands of lamps.

Course Outcome 6 (CO6):

1. Find the gradient of a function $f(x_1,x_2) = 6x_1^2-6x_1x_2+2x_2^2-x_1-2x_2$.
2. Minimize the function $f(x_1,x_2) = 6x_1^2+2x_2^2$ from the starting point (1,2) by univariate search method.
3. Minimize the function $f(x_1,x_2) = 2x_1^2+2x_1x_2+x_2^2+x_1-x_2$.

Concept map



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 Contents and Lecture Schedule

S.No	Topics	No.of Lectures	Course Outcomes
	Sampling Distribution & Estimation		
1.1	Sampling-distribution statistics, Standard error	2	CO1
	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	CO2
	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	CO3
3.2	Rank Sum test	2	
	Tutorial	1	
3.3	Mann Whitney U-test, Kruskal Wallis test	2	CO4
	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	CO5
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	CO6
	Tutorial	1	
5.3	Descent Method, Steepest Descent Method	2	
	Tutorial	1	
	Total	**3**	

Course Designer

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22CM120	MODERN CONSTRUCTION MATERIALS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

This course gives the detailed experimental study on basic materials of construction and modern material

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statement	Bloom's Level
CO1	Identify the structural and physical applications of advanced materials used in concrete.	Understand
CO2	Enumerate manufacturing process, properties and applications of special concrete	Understand
CO3	Choose the type of metals and alloys for construction applications	Apply
CO4	Choose appropriate composites for various construction applications knowing its properties and uses.	Apply
CO5	Compare the properties and usage of adhesives and sealants in buildings	Apply
CO6	Select smart materials suitable for various structures	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium;L-Low

Assessment Pattern: Cognitive Domain

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the Properties of High Strength and High-Performance Concrete.
2. Write the Properties of advanced construction materials.
3. Explain the structural Applications of advanced construction materials.

Course Outcome 2 (CO2):

1. Enumerate the manufacturing process of special concrete.

2. Write the Properties and Applications of Fibre Reinforced Concrete.
3. Explain the Properties and Applications of Self- compacting concrete

Course Outcome 3 (CO3):

1. Choose the type of metal predominantly used in construction works.
2. Write the Advantages of new alloy steels
3. Discuss the Types of Coatings & Coatings to reinforcement

Course Outcome 4 (CO4):

1. Explain the Properties & Manufacturing process of plastics.
2. Write the Advantages of Reinforced polymers
3. Discuss the Applications of FRP

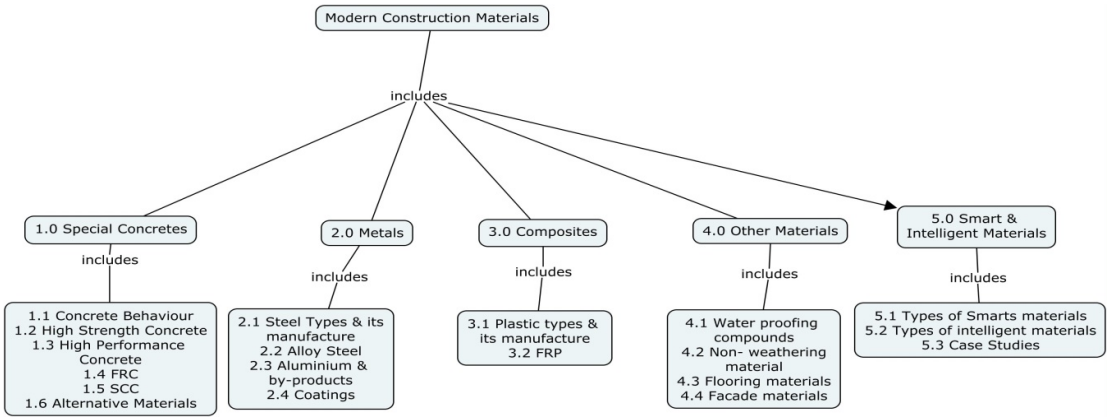
Course Outcome 5 (CO5):

1. Write the Types and properties of Water Proofing Compounds
2. Discuss Types of Flooring Materials and its application
3. Explain Types of Facade Materials and its application

Course Outcome 6 (CO6):

1. Explain Types of smart and intelligent materials
2. Write the Differences between Smart and Intelligent Materials
3. Discuss Special features of Smart and Intelligent Materials

Concept Map



Syllabus

Special concretes Concrete -Behaviour of concretes – Properties and Advantages of High Strength and High-Performance Concrete – Properties and Applications of Fibre Reinforced Concrete, Self- compacting concrete, Alternate Materials to concrete on high performance & high Strength concrete. **Metals** Types of Steels – Manufacturing process of steel – Advantages of new alloy steels – Properties and advantages of aluminium and its products – Types of Coatings & Coatings to reinforcement – Applications of Coatings. **Composites** Types of Plastics – Properties & Manufacturing process – Advantages of Reinforced polymers – Types of FRP – FRP on different structural elements – Applications of FRP. **Other Materials -** Types and properties of Water Proofing Compounds – Types of Non-weathering Materials and its uses – Types of Flooring and

Facade Materials and its application. **Smart and Intelligent Materials** Types & Differences between Smart and Intelligent Materials – Special features – Case studies showing the applications of smart & Intelligent Materials.

Reference Books

1. Ganapathy, C. “Modern Construction Materials”, Eswar Press, 2015.
2. Ashby, M.F. and Jones D.R.H.H. “Engineering Materials 1: An introduction to Properties, applications and designs”, Elsevier Publications, 2005.
3. Santhakumar A.R. “Concrete Technology”, Oxford University press, New Delhi.
4. Shan Somayaji, Civil Engineering Materials, Prentice Hall Inc., 2001
5. Shetty M.S, Concrete Technology: Theory and Practice, S.Chand & Company Ltd., 2005.

Course contents and Lecture Schedule

Module No	Topics	No.of Lectures	COs
1.0	**Special concretes**	1	CO1
1.1	Concrete -Behaviour of concretes	1	CO1
1.2	Properties and Advantages of High Strength Concrete	1	CO1
1.3	Properties and Advantages of High-Performance Concrete	1	CO1
1.4	Properties and Applications of Fibre Reinforced Concrete	1	CO2
1.5	Properties and Applications of Self- compacting concrete	1	CO2
1.6	Alternate Materials to concrete on high performance & high Strength concrete	1	CO2
2.0	**Metals**		
2.1	Types of Steels – Manufacturing process of steel	1	CO3
2.2	Advantages of new alloy steels	1	CO3
2.3	Properties and advantages of aluminium and its products	2	CO3
2.4	Types of Coatings & Coatings to reinforcement	2	CO3
2.5	Applications of Coatings	1	CO3
3.0	**Composites**		
3.1	Types of Plastics	1	CO4
3.2	Properties & Manufacturing process of plastics	2	CO4
3.3	Advantages of Reinforced polymers	2	CO4
3.4	Types of FRP	2	CO4
3.5	FRP on different structural elements	1	CO4
3.6	Applications of FRP	1	CO4
4.0	**Other Materials**		
4.1	Types and properties of Water Proofing Compounds	2	CO5
4.2	Types of Non-weathering Materials and its uses	2	CO5
4.3	Types of Flooring Materials and its application	2	CO5
4.4	Types of Facade Materials and its application	2	CO5
5.0	**Smart and Intelligent Materials**		
5.1	Types of smart and intelligent materials	1	CO6
5.2	Differences between Smart and Intelligent Materials	1	CO6
5.3	Special features of Smart and Intelligent Materials	1	CO6
5.4	Case studies showing the applications of smart & Intelligent Materials	2	CO6

Course Designer

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22CM130	CONSTRUCTION EQUIPMENT MANAGEMENT	Category	L	T	P	Credit
		PC	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	Course Outcome Statements	Bloom's Level
CO1	Explain the significance of equipment management and Choose an appropriate equipment for a specific purpose	Apply
CO2	Estimate various cost components of equipment	Apply
CO3	Compare and contrast various financing decisions for equipment purchase, operation and Maintenance in relation to its life cycle.	Apply
CO4	Estimate & Optimize equipment system productivity	Analyze
CO5	Demonstrate how to convert a linear schedule into a precedence diagram to achieve target production rates	Analyze
CO6	Understand effective construction equipment maintenance & lower the cost of operating the equipment contemplated in the estimate	Apply

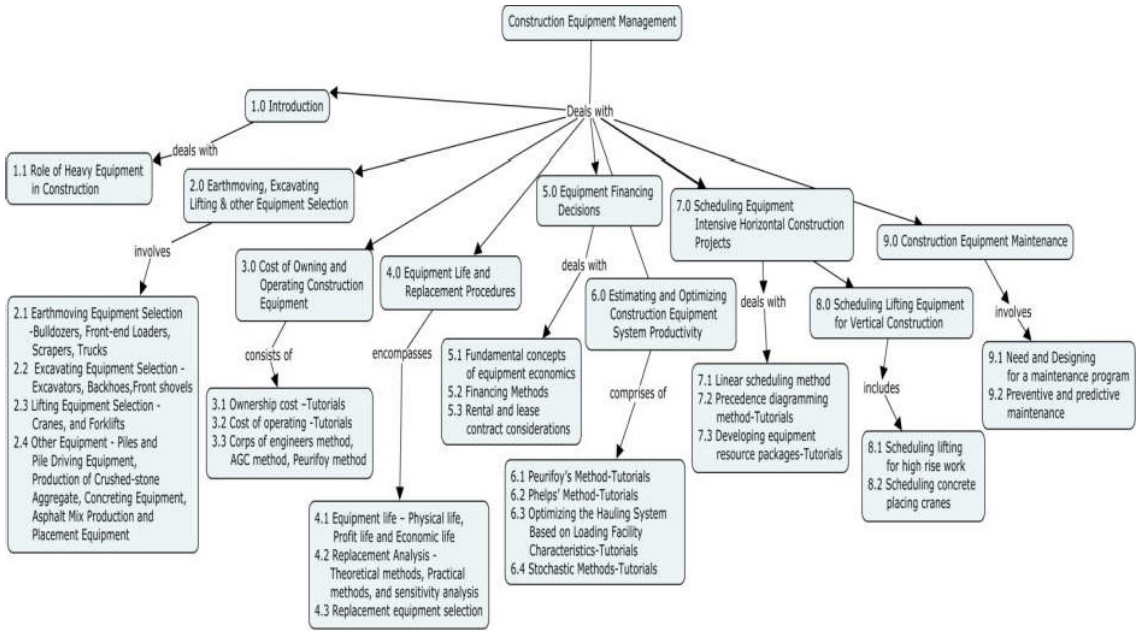
Mapping with Programme Outcomes

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

Assessment Pattern: Cognitive Domain

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	20	20
Understand	30	20	20
Apply	50	50	50
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Concept Map



Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Recall Standard Industrial Classification.
2. Write short notes on (i) Asphalt mix production and placing equipment (ii)Forklift
3. For a mega infrastructure project, the process is going to start with site clearance and deep cutting. As an Equipment manager, Suggest and Explain the category of equipments will be suitable for the mentioned task.

Course Outcome 2 (CO2):

1. Differentiate Ownership and Operating Cost.
2. Summarize the other methods for calculating Ownership and Operating cost(Except Traditional method)
3. The Front end loader has been used for the earthmoving operation intended for construction of a canal. The 40% of time the engine will work @ full power for pushing the load and remaining cycle it uses half of the power for reverse activity. You are assigned to estimate Hourly Total cost of equipment for the first year of operation. The data given below. Assume data if required.

S. No	Items Name	Data
1	Horse Power	335 hp
2	Operating Hours	3000 hr/yr
3	Initial Cost(in $)	3,00,000
4	Tire cost(in $)	55,000
5	Estimated life	5 years
6	Salvage value	40,000
7	Interest on Investment	8.5%
8	Insurance, Tax & Storage	2%,3.5%, 0.55%

S. No	Items Name	Data
10	Type of engine	Diesel
11	Efficiency of engine	45 min/hr
12	Crankcase capacity	8.5 gal
13	Oil change	180 hrs
14	Fuel cost(in $/gal)	3.0
15	Lubricant cost(in $/gal)	2.5
16	Mobilization & Demob. cost(in $)	30,000
17	Operator's wages (in $)	350

9	Tire's expected life	5000 hrs

18	Cost of high wear items(in $)	2000

.

Course Outcome 3 (CO3):

1. Draw Equipment Life cycle stages using graph.
2. Discuss about Decision making foundations in Equipment Replacement decision making process.
3. A construction equipment dealers finance the equipments over 10 years. Now the profit from the business has reduced due to equipment deterioration. The company decided to analyze the replacement of equipments in usage. As an equipment manager, explain the various theoretical methods available for replacing the equipments to improve overall success rate of company profile.

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Course Outcome 4 (CO4):

1. Differentiate Instantaneous production and Sustained production.
2. Describe the construction procedure of Load growth curve with graph.
3. A Private construction organization awarded a contract of canal project. The Front end loader of 2 different specifications (F1, F2). Specification for Haul unit is shown in the table. Analyze the different specification and select an optimum specification from project's productivity perspective.

General Data	
Bucket size	4.0 CY
Material Quantity	20,000 cubic yards
Initial cost of project	$480/hr
Road length	4000 ft
Rolling resistance	25 lbs/cubic yard
Slope	-0.52% in Return Direction
Speed limit of road	80mph

Specifications	F1	F2
Capacity (cubic yards)	13	11
Horse Power	239	220
Efficiency	0.85	0.7
Weight @ empty (tons)	23.5	20.5
Weight @ loaded (tons)	49.8	40.5
EOC ($/hr)	15.0	16.0
MOC ($/hr)	8.5	8.5
Labour ($/hr)	12.5	12.0
Loading time(in min)	3.0	3.2
Waste time(in min)	1.9	1.9
Dump time(in min)	2.5	2.2

Course Outcome 5 (CO5):

1. Why PDM is better than traditional method of scheduling?
2. Examine the process involved in concrete ordering, scheduling & placing in a project.
3. A Contractor awarded a project of shopping mall construction. Find following as per Conservative Schedule & Precedence Diagramming Method. (i) Project Duration (ii) Critical Activities (iii) Daily & cumulative cost (No need to plot graph)

S. No.	Activities	Duration(Days)	Cost (Rs.)	Lag in activities
1	Clear the demolished material	4	45,000	3
2	Compaction of earth	3	50,000	1
3	Construction of base foundation	6	82,000	-

Course Outcome 6 (CO6):
1. Explain the significance of a maintenance program
2. Recall Maintenance Work Order.
3. Prepare a methodology of Designing a maintenance program for improving equipment productivity.

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 Decision**s – Fundamental Concepts of Equipment economics - Financing methods, Rental and lease contract considerations, **Estimating and Optimizing Construction Equipment System Productivity** – Theory on 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; **Scheduling Lifting Equipment for Vertical Construction**; **Construction Equipment Maintenance.**

Course Content and Lecture Schedule

Module No.	Topics	No. of Lecture	Course Outcome
1	**Introduction**		
1.1	Role of Heavy Equipment in Construction	1	**CO1**
2	**Earthmoving, Excavating Lifting and other Equipment Selection**		
2.1	Earthmoving Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks	1	**CO1**
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	1	
3	**Cost of Owning and Operating Construction Equipment**		
3.1	Ownership cost – depreciation cost-Tutorials	2	**CO2**
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	**CO3**
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	**CO3**
5.2	Financing Methods	2	
5.3	Rental and lease contract considerations	1	
6	**Estimating and Optimizing Construction Equipment System**		
6.1	Peurifoy's Method-Tutorials	2	**CO4**
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	3	**CO5**
7.2	Precedence diagramming method	2	
8	**Scheduling Lifting Equipment for Vertical Construction**		
8.1	Scheduling lifting for high rise work	1	**CO5**
8.2	Scheduling concrete placing cranes	1	
9	**Construction Equipment Maintenance**		
9.1	Need and Designing for a maintenance program	1	**CO6**
9.2	Preventive and predictive maintenance	1	
	Total Hours	**36**	

References

1. Gransberg, D.G., Popescu, C. M., and Ryan, R. C., "Construction equipment management for engineers, estimators, and owners", Taylor & Francis, New York, 2006.
2. 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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22CM140	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 Statements	Bloom's Level
CO1	Formulate problems mathematically using the concept of Linear Programming (LP)	Apply
CO2	Solve LP problems by graphical, Simplex method, Artificial Variable Technique – Big M method	Apply
CO3	Solution of LP problems by Artificial variable technique -Two phase technique, Duality concept; identify the special cases in obtained solution	Apply
CO4	Solve transportation, assignment and traveling salesman problems	Apply
CO5	Apply Dynamic Programming to shortest route problems, capital budgeting problems and LPP	Apply
CO6	Apply game and decision theories to problems and understand the principle of Monte-Carlo simulation	Apply

Mapping with Programme Outcomes

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

Assessment Pattern

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

. Course Level Assessment Questions

Course Outcome 1 (CO1):

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 profitsubject 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. 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 deluxein 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 tilesit requires 2.5 hours and 20 deluxe tiles 10 hours of labour. The profit for 100 regular tilesis Rs.50/- and 25 deluxe tiles is Rs.75/-. Formulate the LPP
3. Discuss the various types of OR model. Write the principles of modeling OR problems

Course Outcome 2 (CO2):

1. Discuss the special cases in Simplex method of solution of LPP
2. Solve the following LPP by 2–phase technique. Minimize Z = -3X1+X2
   Subject to: $2X1 + X2 \geq 2$; $X1 + 3X2 \leq 2$; $X2 \leq 4$; & $X1, X2 \geq 0$
3. Using Simplex Method
   Maximize Z= X1+2X2-X3
   Subject to: $2X1+X2+X3 \leq 14$, $4X1+2X2+3X3 \leq 28$, $2X1+5X2+5X3 \leq 30$,
   $X1 \geq 0$; $X2 \geq 0$; X3 is unrestricted in sign

Course Outcome 2 (CO3):

1. Solve the following LPP by Duality concept and determine the solution of both Primal and Dual

   LPPs: Maximize (Z) = X 1 + 9X 2 Subject to: 2X 1 + X 2 ≥25, X 2 ≤ 11, X 1 , X 2 ≥ 0

2. Find the solution of the following LPP by Two phase Technique :

   Minimize (Z) = X 1 + 4X 2 - 8X 3

   Subj. to: 3X 1 + 17X 2 + 2X 3 ≥ 5; 5X 1 + 4X 2 - 2X 3 ≤ 2; X 1 , X 2 ≥ 0, X 3 - unrestricted

Course Outcome 3 (CO4):

1. Write the aim of traveling salesman problem
2. Identify under what circumstances assignment problems are considered as a special caseof transportation problem
3. 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.

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

Course Outcome 4 (CO5):

1. Use Dynamic Programming (DP) and solve the following short route problem anddetermine the shortest distance between cities 1 and 10

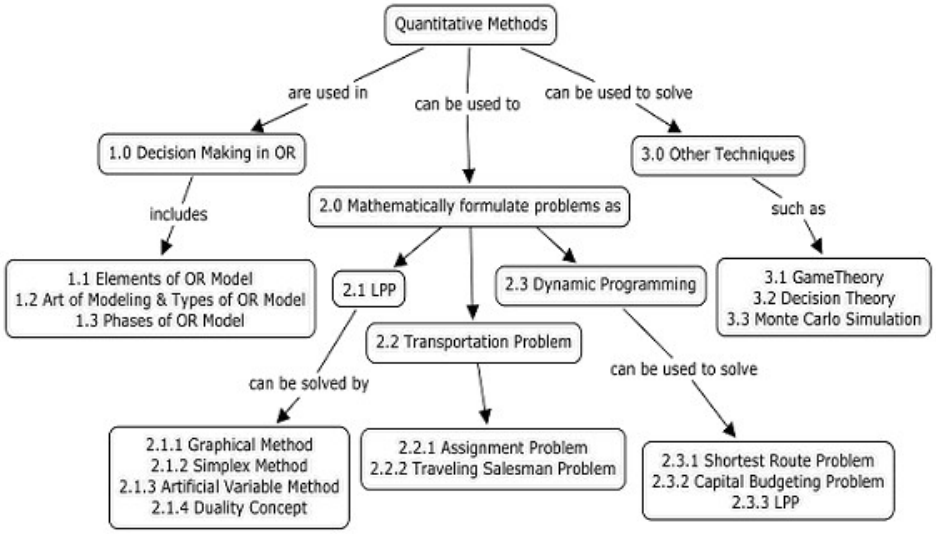
City (i –j)	1-2	1-3	2-4	3-4	2-5	3-6	4-8	4-9	4-7	5-7	6-7	6-9	7-10	5-8	8-10	9-10
Dist. miles	2	2	3	5	2	4	7	8	2	1	9	2	6	7	2	3

2. Discuss with an example why DP is called multistage decision process
3. Differentiate the terms state and stage in DP

Course Outcome 5 (CO6):

1. Distinguish between the solutions derived from Simulation models and that derived fromanalytical models
2. Discuss the implication of two person zero sum game with an application
3. Enumerate the principle of Monte Carlo simulation with an application

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

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1. Hamdy A. Taha, "Operations Research, An Introduction", Prentice Hall of India Pvt. Ltd., New Delhi-2013
2. Prem Kumar Gupta and D.S. Hira. "Problems in Operations Research", S. Chand & Co Pvt Ltd, 2015
3. S.S. Rao, "Optimization- Theory and Applications", New Age International (P) Ltd., Publishers 2001
4. N. Krishna Raju and K.U. Muthu, "Numerical Methods in Engineering Problems", McMilan India Ltd., 1996

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcomes
1.0	**Decision Making in OR**		
1.1	Optimization – meaning. Elements of OR Model	1	**CO1**
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	**CO2**
2.1.1	Graphical solution of two variable problems- Special		
2.1.2	Simplex method - computational procedure &	2	
	Tutorial	2	
2.1.3	Artificial variable Technique– M technique- procedure	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	1	
	Tutorial	2	
2.2	**Transportation problems**		
2.2	Transportation problems- objectives- Vogel's Approximation method,	2	**CO3**
2.2.1	Assignment Problem- objective, Hungarian method of solution – problems	2	**CO4**
2.2.2	Traveling salesman problem- concept and		
	Tutorial	2	
2.3	**Dynamic Programming**		
2.3.1	Multistage decision process– Bellman's principle Shortest route problem – computational procedure - Problems	2	CO5
2.3.2	Capital budgeting problem – Computational	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	CO6
3.2	Decision Theory - procedure and problems	1	
3.3	Simulation – Monte Carlo simulation – brief concept	1	
	Tutorial	2	
	Total Periods	**36**	

Course Designers:

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22CM160	PROJECT FORMULATION AND IMPLEMENTATION	Category	L	T	P	Credit
		PC	2	0	2	3

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, estimating project cost, assessment methods, analyze risk and private sector participation in infrastructure development projects. .

Course Outcomes

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

COs for Theory part:

Course Outcome		Bloom's Level
CO1	Enumerate the need and procedure for project formulation	Apply
CO2	Analyse the feasibility of the project	Analyze
CO3	Understand the various sources of finance and key financial indicators in project financing	Understand
CO4	Enumerate the methods of risk analysis in projects	Apply
CO5	Apply knowledge on contract types in infrastructure projects and suggest solutions to possible contractual problems	Apply

COs for Practical part:

Course Outcome		Bloom's Level
CO6	Identify and formulate project to develop feasibility report	Apply
CO7	Analyse the profitability of a project in terms of its capital investment	Apply
CO8	Identify suitable sources of finance and perform risk analysis	Apply
CO9	Select appropriate contract for project implementation	Apply
CO10	Prepare tender and contract document for project	Apply

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			Terminal exam	
	Theory Part		Practical Part	Theory Part	Practical Part
	Test 1	Test 2			
Remember	20	20	Observation, Record, Model Test (100)	20	100
Understand	20	20		20	
Apply	60	60		60	
Analyse	-	-		-	
Evaluate	-	-		-	
Create	-	-		-	

Course Level Assessment Questions

Course Outcome 1(CO1):

1. What are the goals & targets of Government for Infrastructure development?
2. Explain the overview of Initial Screening report
3. Assume that you are given with the role of urban planning manager for the preparation of Detailed Project Report for an infrastructure project. Summarize the methodology of DPR with case study of your choice.

Course Outcome 2(CO2):

1. Discuss the term capital budgeting
2. Summarize the various types of project appraisal involved in the project.
3. The City development division in the city decided to develop facilities in the society. As a City Infrastructure Engineer analyze the project & Prioritize based on Net Present value criteria. Take discount rate as 15%

Year	Cash Flow for Exclusive bus lanes project (cost rs in lakhs)	Cash Flow for Recycle of waste water project (cost rs in lakhs)	Cash Flow for Solar lighting project (cost rs in lakhs)
0	20	15	23
1	5	3	2
2	4	5	5
3	5	5	3
4	2	2	3
5	3	2	6
6	3	2	5

Course Outcome 3(CO3):

1. Draw the generic structure of Project finance.
2. Summarize about Financial Institutions in India.
3. Illustrate the Key performance Indicators for project finance

Course Outcome 4(CO4):

1. Write the methodology of Risk Management
2. Summarize risk with severity matrix and risk event graph concept.
3. A project with uncertainties involving an outlay of Rs.1,00,000. Do the risk analysis using Hillier Model of Uncorrelated Cash flows as follows and determine various possibilities.

   1.Probability that NPV>0

   2.Probability that NPV<0

   3.Probability that NPV=Mean

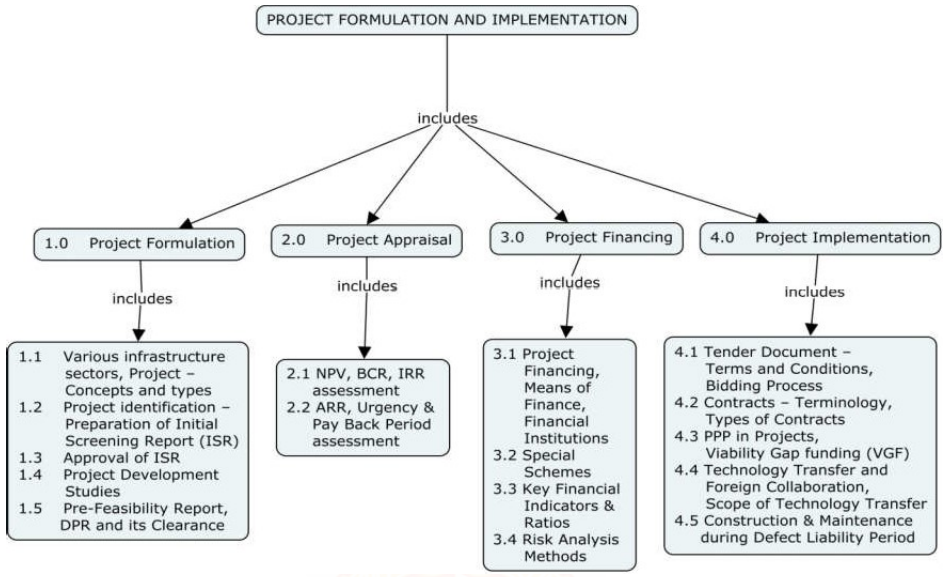
Year 1		Year 2	
Net Cash flow	Probability	Net Cash flow	Probability

50000	0.2	33000	0.4
25000	0.5	40000	0.2
32000	0.3	30000	0.4

Course Outcome 5(CO5):

1. Recall the term Contract.
2. Write short notes on Public Private Partnership
3. Correlate the features of Technology transfer and Foreign collaboration with Infrastructure growth in country.

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.

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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” , McGraw Hill 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

Course Content and Lecture Schedule (Theory Part)

Module No.	Topics	No. of Lectures	Course Outcome
1.0	**Project Formulation**		
1.1	Introduction to various Infrastructure Sectors, Project – Concepts, types of projects based on nature	2	**CO1**
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	**CO2**
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	**CO3**
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	**CO4**
4.0	**Project Implementation**		
4.1	Tender Document – Terms and Conditions, Bidding Process	2	**CO5**
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	Course Outcome
1	Selection of project and preparation of Initial Screening Report with proper justification	2	CO6
2	Preparation of Detailed Project Report for a given project	2	
3	Preparation of prefeasibility report with required data for the chosen project	2	
4	Identification of the various approval required for the chosen project with time frame and appropriate sanctioning authorities	2	
5	Examine the viability of project appraisal for the chosen project by discounting method	2	CO7
6	Examine the viability of project appraisal for the chosen project by non-discounting method	2	
7	Identify the various sources, modes of Finance and Financial institutions to be approached for funding of the project	2	CO8
8	Identify and manage the risk in the project by suitable methods and Prepare a suitable risk management plan for the chosen project	2	
9	Identify and select suitable Governmental/ Non-Governmental schemes for the selected project. Draft the benefits to the project through the schemes	2	
10	Preparation of contract document for the project	2	CO9
11	Identify and document issues likely to appear during Defect Liability period for the project	2	
12	Preparation of tender document and tender notice for the project	2	CO10
	Total Hours	**24**	

Course Designers:

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22CM170	ADVANCED CONSTRUCTION ENGINEERING LABORATORY	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

To provides a thorough knowledge of material selection through the material testing based on specification

Prerequisite

Concrete technology

Course Outcomes

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

COs	Course Outcome Statement	Bloom's Level
CO1	Design concrete mix proportion using IS and ACI codal provisions.	Apply
CO2	Identify the appropriate proportions of mineral and chemical admixture for concrete.	Apply
CO3	Perform tests on Fresh Concrete properties	Apply
CO4	Conduct Test on Hardened Concrete properties	Apply
CO5	Test the concrete in a non-destructive manner using various methods	Apply
CO6	Conduct tests on rebar used in concrete	Apply
CO7	Conduct tests on concrete beam	Apply

LIST OF EXPERIMENTS

1. Tests on Cement
2. Tests on Fine Aggregate
3. Tests on Coarse Aggregate
4. Mix design of concrete as per IS, ACI and IRC methods
5. Casting and Testing of fresh concrete
6. Testing of hardened concrete
7. Tests on rebar, Measurement of concrete cover, Bend-R-Bend test
8. NDT on hardened concrete - UPV, Rebound hammer test
9. Corrosion test on concrete specimens
10. Flexural Strength of Concrete Beam using Centre Point Loading Method
11. Calibration of Proving Ring and LVDT
12. Flexural Strength of RCC beam - Demonstration

Course Designers

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22CM260	PROJECT PLANNING AND CONTROL	Category	L	T	P	Credit
		PC	2	0	2	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 for Theory part:

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

COs for Practical part:

COs	Course Outcome Statements	Bloom's Level
CO6	Create a Calendar and Work Break Down Structure (WBS) for a project	Understand
CO7	Defining activities and relationship. Develop network and its duration	Apply
CO8	Scheduling of projects and defining resources for activities	Apply
CO9	Analyze and update projects, identify change in critical path and revised duration	Apply
CO10	Balance resource in projects	Analyze
CO11	Conduct Earned Value Analysis of projects	Analyze
CO12	Generation of Project Report	Apply

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			Terminal exam	
	Theory Part		Practical Part	Theory Part	Practical Part
	Test 1	Test 2			
Remember	10	10	Observation, Record, Model Test (100)	10	100
Understand	30	20		10	
Apply	60	60		60	
Analyse	-	10		20	
Evaluate	-	-		-	
Create	-	-		-	

Course Level Assessment Questions

Course Outcome 1(CO1):

1. Discuss the functions of project management
2. Discuss the essential conditions to be satisfied for sanction of projects
3. Explain the meaning and significance of Statement of Work in relation to projects

Course Outcome 2 (CO2):

1. A project consists of 12 activities. The time required for each activity is given in the table below. Use the following logical relationships and draw a network diagram for the project and determine the critical path and duration required for completion of the project.

- Activity A,D and H can be performed concurrently and represent the start of the project
- B succeeds A; C and G follow H; D,C and B precede F; L follows A
- M comes after G; K is preceded by L; X cannot start until K, F and M are completed
- Z succeeds G; X and Z are last operations

Activity	A	B	C	D	F	G	H	K	L	M	X	Z
Duration (days)	4	3	2	4	7	3	2	4	8	3	2	1

2. Discuss the merits and limitations of bar-chart technique
3. A project consists of 5 activities with the following relationship. Draw a bar chart assuming that the project commences on 15th April, wednesday with five working days a week. Determine the project completion day and date. What is the total duration of the project?
   A is the initial activity with duration of 7 days for completion

   A is followed by B and D with duration of 2 days and 5 days respectively

   E can start after half the work of B is over and it takes 9 days for completion D and B precede F which takes 5 days for completion

Course Outcome 3 (CO3):

1. List the resources for a project
2. The following table gives the manpower requirements for each activity in a project:

i) Draw the network diagram of the project
ii) Rearrange the activities suitably for reducing the existing total manpowerrequirement

iii) Also determine the % reduction in peak demand for the resources

Activity (i-j)	0-1	1-2	1-3	2-4	3-5	3-6	4-7	5-7	6-8	7-9	8-9
Duration (days)	2	3	4	2	4	5	6	5	3	4	4
Manpower demand	4	3	2	5	3	4	4	6	2	2	8

3. Balance the resource demand for the following project so as to meet the availabilityof only 7 men/day

Activity (i-j)	0-1	0-3	0-6	1-2	3-4	3-7	6-7	2-5	4-5	7-8	5-8
Duration (days)	2	2	1	4	5	8	3	1	4	5	3
Manpower	3	6	4	2	2	4	5	4	2	2	5

Course Outcome 4 (CO4)

1. A project consists of 5 activities with the following relationship. Draw a bar chart. Determine the project completion day and date. What is the total duration of the project?

I. A is the initial activity with duration 7 days for completion

II. A is followed by B and D with duration of 5 days and 4 days respectively

III. E can start after half the work of B is over and it takes 9 days for completionD and B precede F which takes 5 days for completion

IV. If on the 11th day of commencement the following status occurs, update the projectand determine the revised completion time if any?

V. A is completed as per schedule

VI. B is in progress and requires 2 more days for completion

VII. D is delayed by 7 days and it requires 8 more days for its completion E is in progress and the original time will hold good; F is yet to start

2. Define updating of projects mentioning its significance
3. The following table shows the activities of a project with their durations of completion.The following conditions exist at the end of 11 days.

Activity (i-j)	1-2	1-3	1-4	2-5	4-6	3-5	3-6	3-7	5-7	6-7
Duration (days)	2	3	5	3	3	5	4	3	2	7

I. Activities 1-2,1-3 and 1-4 have been completed as originally planned Activity 3-5 is in progress and will require two more days for completion Activity 3-6 is in progress and will require three more days for completion

II. Activity 4-6 is in progress and will be completed in five days

III. All other activity are yet to start and their predicted durations will hold good except 6- 7 which will require only 5 days instead of 7 days originally planned

IV. Update the project and determine the critical path of the updated network. What isthe revised project completion time? Also show the details on a bar chart

Course Outcome 5(CO5):

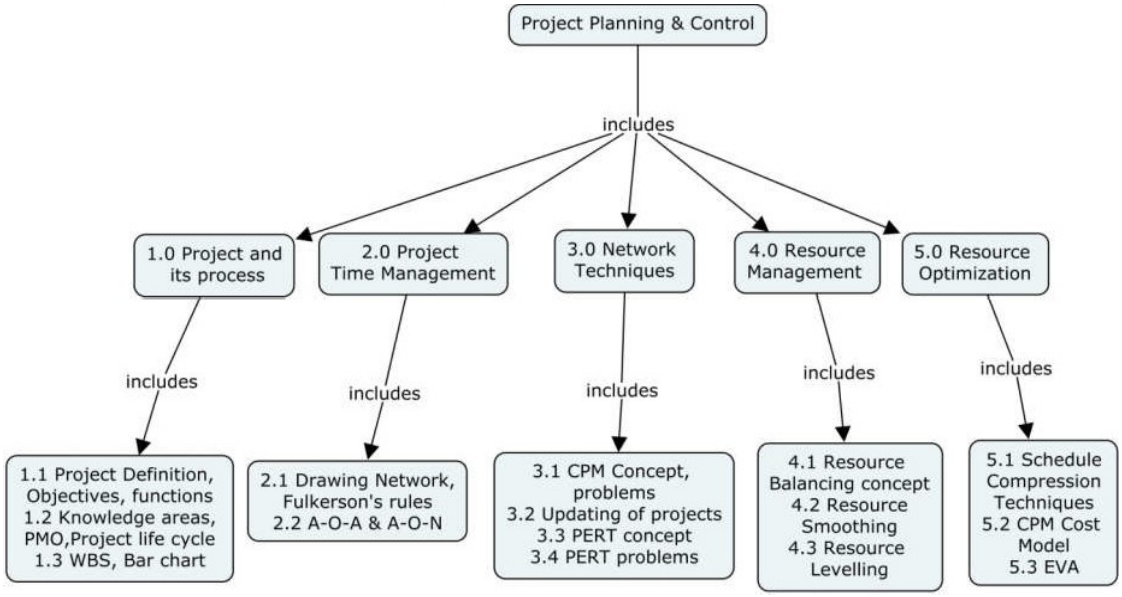
1. The following table gives data related to activities in a project. Crash the project to minimum project duration and determine the minimum cost and

optimum time of completion. Assume indirect cost as Rs.1400/ week.

Activity	Normal		Crash	
	Time (days)	Cost (Rs.)	Time (days)	Cost (Rs.)
0-1	1	5000	1	5000
1-2	3	5000	2	12000
1-3	7	11000	4	17000
2-3	5	10000	3	12000
2-4	8	8500	6	12500
3-4	4	8600	2	16500
4-5	1	5000	1	5000

2. List the benefits and limitations of latest tools in project management
3. Compare the behaviour of direct and indirect cost of a project with respect to time anddraw its relationship. If there is a loss encountered in a project during its execution, what would be it's impact on the total cost of the project?

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.

Course Contents and Lecture Schedule (Theory Part)

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction to Project Management**		
1.1	Define project and process, boundaries of project Introduction to project management concept, background of management, purpose, objectives, Characteristics of projects, Organization structure / styles of project and Functions of management	1	CO1
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	Traditional management systems – Gantt approach, progress-chart, Bar-chart- Merits and limitations	1	
1.4	Problems in Bar-chart	1	
1.5	Work study, work break down structure, time estimate	1	
	Tutorial	1	
2.0	**Project Programming**		
2.1	Introduction to modern management concepts, uni-dimensional management techniques	1	CO1
2.2	Introduction to network concepts, network elements and inter-relationships	1	
2.3	Network techniques, network logic- inter- relationships activity information, data sheets	1	
2.4	Development of network based on Fulkerson's rules	1	
2.5	Problems in development of network		
	Tutorial		
3.0	**Network Techniques**		
3.1	Critical Path Method (CPM) for management, CPM network analysis	1	CO2
3.2	Identification of critical path, floats, square network diagrams-problems	1	
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 of PERT network – problems, Delta Charts – concept and applications	1	
	Tutorial		
4.0	**Resource Balancing**		
4.1	Resource balancing- objectives, resource smoothing technique – concept and procedure	1	CO3
4.2	Problems using resource smoothing technique	2	
4.3	Resource Levelling technique - concept and procedure		
4.4	Problems using Resource Levelling technique	2	
	Tutorial		
5.0	**Project Control and Monitoring**		
5.1	Project programming, phasing of activities programmes, scheduling project control	1	CO4
5.2	Reviewing, updating and monitoring – concept		

5.3	Problems in updating of projects – determination of revised critical path	1	
	Tutorial		
6.0	**Project Cost**		
6.1	Introduction to two-dimensional network analysis – activity cost information, cost –time relationship	2	CO5
6.2	Crashed estimates for the activities, compression potential, cost slope, utility data sheet, project direct and indirect cost		
6.3	Crashed programmes, network compression, least cost solution, least time solution and optimum time solution-Problems		
	Tutorial		
6.4	Life cycle assessment- impacts and economical assessment, Life cycle cost- maintenance and operation, life cycle forecasting – concept and applications, Time value of money. Emerging trends in project management: Project Management using latest tools- Case study	1	
	Total Periods	**24**	

Ex. No.	Title	No. of practical hours
1.	Creating a Calendar (Global, Project and Resource)	2
2.	Creating a Work Break Down Structure for a Residential Building	1
3.	Developing Activities on WBS and its relationship	2
4.	Analyze the project Duration	1
5.	Preparation of Resource sheet with Budgeted Units	2
6.	Resource Study using Histogram and Resource Usage spreadsheet	4
7.	Creation of Baseline and Assigning the baseline for a project	2
8.	Scheduling and Updating the Project	4
9.	Conduct Earned Value Management for the project	4
10.	Generation of Project Report	2
	Total Hours	**24**

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
   SangaReddi. S and Meiyappan. PL, “Construction Management”, Kumaran Publications, Coimbatore, 1999

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		Category	L	T	P	Credit
22CM270	**BUILDING INFORMATION MODELING LAB**	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 intend 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 be able to:

COs	Course Outcomes Statements	Blooms Levels
CO1	Understand concepts of Building Information Modeling (BIM)	Understand
CO2	Review software and technology available for BIM	Apply
CO3	Use BIM software create a model of a building	Apply
CO4	Use BIM to check for interferences and conflicts on a building construction project	Apply
CO5	Explore construction scheduling and sequencing using BIM	Apply
CO6	Explore cost estimating using BIM	Apply

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

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.
11. Preparing a 3D model of G+2 storey residential building incorporating the essential features given its plan
12. Preparing a 3D model of a metro station building given its plan

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

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22CMPA0 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	Course Outcome	Bloom's Level
CO1	Understand the Tendering Process and evaluation process of Tendering	Understand
CO2	Understand the various clauses of construction contracts with their legal aspects and its provisions	Apply
CO3	Apply knowledge on different types of contracts for selecting suitable type of contracts in construction projects	Apply
CO4	Explain the need, importance of labour regulations for construction industry	Apply
CO5	Suggest suitable type of dispute resolution for the given situation of problem	Apply
CO6	Explain the UNCITRAL model law and Arbitrator Tribunal	Apply

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	S	S	M	---	M	M	S	M	S	L	S	M
CO5	S	M	M	L	---	L	M	S	M	M	M	S	M
CO6	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	
Remember	10	10	10
Understand	30	30	30
Apply	60	60	60
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1(CO1)

1 Explain the procedure of tendering and selection of successful contractor for projects

2 Discuss issues related to e-tendering process.

3 The highway department of government is planning to construct a new highway line in a city, as a chief engineer of the department you are vested with the responsibility of preparing tender documents for calling for tenders to invite prospective bidders to take up the work. Identify the items to be included in the tender documents and discuss them

Course Outcome 2(CO2)

1. Discuss about the various contract types and its merits and demerits
2. How Contract Document is different from Tender Document
3. Discuss in detail about various clauses of Contracts in Indian Contract Law.

Course Outcome 3 (CO3)

1. Discuss about the Prequalification Meeting and explain its significance
2. A proposed construction in OMR for a stretch of 0.8KM is given by NHAI, as Project Manager which type of Contract you will chose for the work and justify with appropriate methodology.

Course Outcome 4(CO4)

1. Discuss the salient features of laws related to construction industry.
2. For a major project involving huge sum of money suggest a suitable type of contract. Give justifications for your choice
3. Explain briefly the content of Indian Contract Act.

Course Outcome 5(CO5)

1 As an arbitrator discuss the procedural difference between a judge and an arbitrator. Who is more powerful in what situation? Discuss

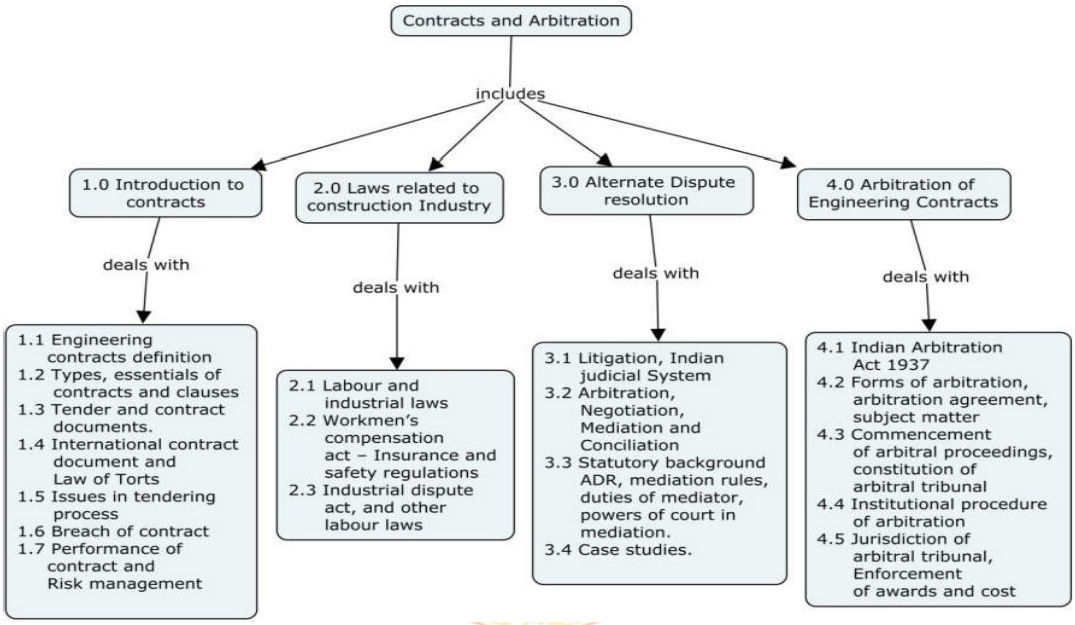
2 As an infrastructure manager, the knowledge on contracts and arbitration is it essential? Justify

Course Outcome 6(CO6)

1 As a project manager of a infrastructure company you have a major task of managing work force, identify and discuss the aspects contributing to increased performance level of labour.

2 As a contract manager identify the method to select a project based on contract document and issues

Concept Map



Syllabus

Introduction to Tender: Notice Inviting Tender - Preparation of tender documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view in construction industry - e-tendering process - Awarding contract: Issues related to tendering process; **Contracts** - Brief details of Engineering contracts – definition, types and essentials of contracts and clauses for contracts –and standard contract documents – International contract document, World bank procedures and guidelines, - **Fidic Documents** – Type of FIDIC Document for various types of works- Law of Torts –. 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, The Arbitration and conciliation Act 1996, 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.

Course Contents and Lecture Schedule (Theory Part)

Module No.	Topic	No. of
1.0	**Introduction to Contracts**	
1.1	Notice Inviting Tender	1
1.2	Preparation Of Tender Documents - Prequalification, Bidding, Accepting, Evaluation Of Tender Form	1
1.3	Technical, Contractual and Commercial Point Of View In Construction Industry	2
1.4	E-Tendering Process	1
1.5	Awarding Contract: Issues Related To Tendering Process	1
2.0	**Contracts**	
2.1	Brief details of Engineering contracts – definition, types and essentials of contracts	1
2.2	clauses for contracts –and standard contract documents –	2
2.3	International contract document, World bank procedures and guidelines	2
3.0	**FIDIC Documents**	
3.1	Type of FIDIC Document for various types of works.	2
3.2	Law of Torts –. Time of performance – provisions of contract law – Breach of contract	2
3.3	Performance of Contracts – Discharge of a contract- Indian Contract Act 1872	2
3.4	Risk management in contracts	2
4.0	**Laws related to Construction Industry**	
4.1	Labour and industrial laws - payment of wages act, contract labour – Workmen's compensation act.	2

4.2	Insurance and safety regulations, Industrial dispute act, Indian factory act, Child labour act and other labour laws	2
5.0	**Alternate Dispute resolution**	
5.1	Litigation in Indian courts.	2
5.2	Dispute resolution mechanism under the Indian judicial System Arbitration, Negotiation, Mediation and Conciliation - concepts and purpose, Statutory back ground ADR	2
5.3	mediation rules, duties of mediator and disclose facts, power of court in mediation, Case studies	2
6.0	**Arbitration of Engineering Contracts**	
6.1	Background of Arbitration in India, The Arbitration and conciliation Act 1996	1
6.2	UNCITRAL model law, Forms of arbitration – arbitration agreement, subject matter and violations, Commencement of arbitral proceedings	2
6.3	Constitution of arbitral tribunal, appointment of arbitrator and rules of evidence, Institutional procedure of arbitration,	2
6.4	Independence of arbitrators, jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards and cost.	2

References

1. American Arbitration Association, "Construction industry arbitration rules and mediation procedures", 2007
2. Collex.K, "Managing Construction Contracts", Reston publishing company, Virginia, 1982
3. Gajaria. G.T, " Laws relating to building and Engineer's Contracts", M.M. Tripathi Pvt Ltd., Mumbai, 1985
4. Park.W.B., "Construction Bidding for Projects", John Wiley, Norway, 1978
5. Vasavada.B.J. "Engineering Contracts and Arbitration" , March 1996
6. The Arbitration and Conciliation (Amendment) Act, 2015

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22CMPB0	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	Course Outcome Detail (COs)	Bloom's Level
CO1	Illustrate the techno–managerial aspects related to infrastructure sectors and infrastructure projects.	Apply
CO2	Assess the merits and demerits of infrastructure privatization	Apply
CO3	Interpret the challenges in infrastructure planning and implementation.	Apply
CO4	Suggest solutions in infrastructure planning and implementation.	Apply
CO5	Apply strategies for successful implementation of infrastructureprojects.	Apply
CO6	Assess an infrastructure project by performing economic and financial analysis	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO	PO5	PO6	PO7	PO	PO9	PO10	PO1	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	S	S	--	--	--	M	L	--	--	--	M	L
CO6	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	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1(CO1):

1. Write two risks involved in successful implementation of infrastructure projects
2. Give an overview of the power sector in India
3. List the stakeholders of infrastructure projects

Course Outcome 2 (CO2):

1. A National highway in Chennai city is to be privatized. Discuss the benefits andproblems that are likely to occur by this process.
2. Mention two benefits of privatization of infrastructure projects
3. Enumerate the challenges in the privatization of power with the light of a case studyfor a metropolitan city in India

Course Outcome 3 (CO3):

1. A new nuclear reactor plant is to be constructed in a State. Discuss the challenges encountering the successful planning and implementation of the project in relation to the construction and maintenance aspects
2. Discuss the problems with infrastructure privatization
3. Mention two contractual issues affecting infrastructure projects

Course Outcome 4 (CO4):

1. Discuss the strategies to be followed for innovative design and maintenance of infrastructure facilities
2. Discuss the cultural risks related to international infrastructure projects
3. Write the meaning of sustainable development of infrastructure

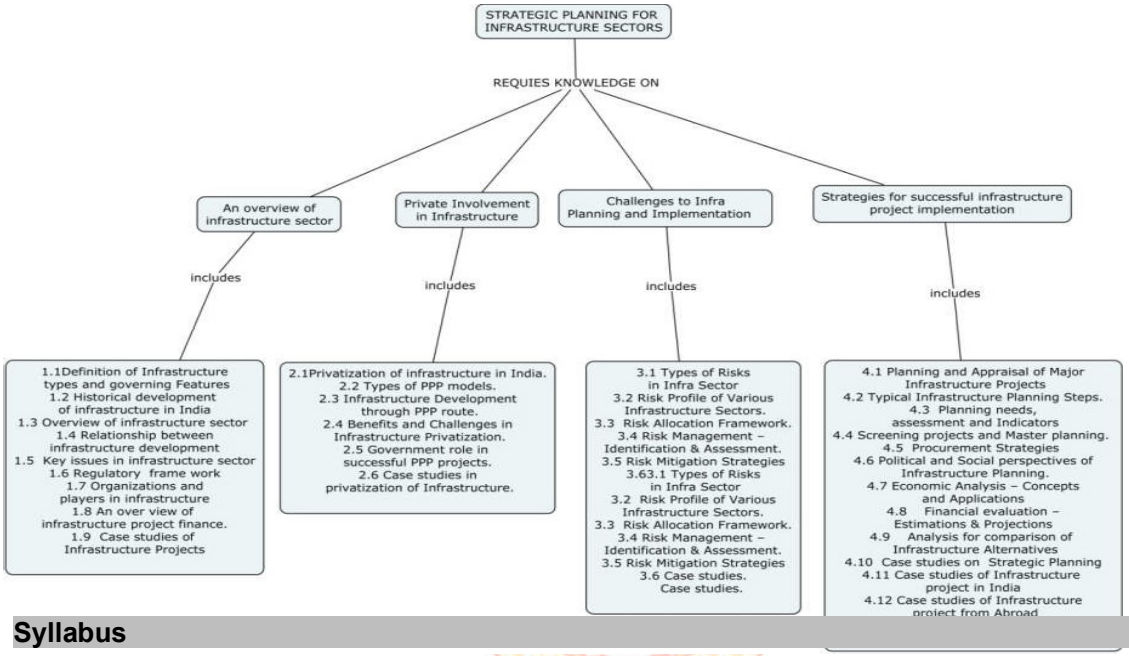
Course Outcome 5 (CO5):

1. In the background of the present energy scenario of Tamil Nadu, propose a thermal power plant (2x660 MW) at the coastal area of Nagapattinam. Discuss the challenges to be faced for implementation of the project.
2. Discuss the Planning and Appraisal of Major Infrastructure Projects
3. List out the steps involved in infrastructure planning.

Course Outcome 6 (CO6):

1. A private airport catering the needs of the tourists for the Sabari Malai holy town is proposed to be implemented. Discuss the viability and issues relating to the formulation of the project
2. Write a note on economic and demand risks related to infrastructure projects
3. Discuss the Political and Social perspectives of Infrastructure Planning

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 Appraisalof Major Infrastructure Projects - Typical infrastructural planning steps - Screening projects and Master planning - Political and Social perspectives of Infrastructure Planning - EconomicAnalysis – 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. VISION –TAMILNADU 2023-Strategic plan for Infrastructure Development in Tamilnadu

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	COs
1.0	**An overview of Infrastructure sector**		
1.1	Definition of Infrastructure types and governing Features	1	CO
1.2	Historical development of infrastructure in India	1	CO
1.3	Overview of infrastructure sectors	1	CO1
1.4	Relationship between infrastructure and Development	1	CO1
1.5	Key issues in infrastructure sector	1	CO1
1.6	Regulatory frame work	1	CO1
1.7	Organizations and players in infrastructure	1	CO1
1.8	An over view of infrastructure project finance.	1	CO1
1.9	Case studies on Infrastructure sector wise Projects.	1	CO1
2.0	**Private Involvement in Infrastructure**		
2.1	Privatization of infrastructure in India.	1	CO
2.2	Types of PPP models.	1	CO2
2.3	Infrastructure Development through PPP route.	1	CO2
2.4	Benefits and Challenges in Infrastructure Privatization.	1	CO2
2.5	Government role in successful PPP projects.	1	CO2
2.6	Case studies on privatization of Infrastructure.	1	CO2
3.0	**Challenges to Infra Planning and Implementation**		
3.1	Types of Risks in Infra Sector	1	CO3

3.2	Risk Profile of Various Infrastructure Sectors.	1	CO3
3.3	Risk Allocation Framework.	1	CO3
3.4	Risk Management – Identification & Assessment.	1	CO4
3.5	Risk Mitigation Strategies	1	CO4
3.6	Case studies on risk allocation.	1	CO4
4.0	**Strategies for successful infrastructure project**		
4.1	Planning and Appraisal of Major Infrastructure Projects	1	CO5
4.2	Typical Infrastructure Planning Steps.	1	CO5
4.3	Planning needs, assessment and Indicators	1	CO5
4.4	Screening projects and Master planning.	1	CO6
4.5	Procurement Strategies	1	CO6
4.6	Political and Social perspectives of Infrastructure Planning.	1	CO6

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22CMPC0	MANAGEMENT OF HUMAN RESOURCE IN CONSTRUCTION	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 manpower management and to help the student further develop their management, team building and leadership skills so as to increase their effectiveness in their job performance on international projects.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	Bloom's Level
CO1	Enumerate the practices and techniques for performance evaluation of HR with coaching and mentoring aspects	Apply
CO2	Apply the principles of HR management in construction projects	Apply
CO3	Explain the role of the leader, leadership principles and attitudes	Understand
CO4	Demonstrate an understanding of professional and ethical responsibilities	Apply
CO5	Demonstrate commitment to quality, timeliness, and continuous improvement.	Apply
CO6	Apply managerial role with a multi-cultural perspective	Apply

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
CO6	S	M	M	L	---	L	M	M	M	M	L	M	M

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Enumerate the practices and techniques for performance evaluation of HR with coaching and mentoring aspects

2. Write the Manpower Planning process - Organising, Staffing, directing, and controlling
3. Explain the Factors influencing supply and demand of human resources

Course Outcome 2 (CO2):

1. Enumerate the Elements of an organisation- Management process in organisations
2. Write the Planning-Organising-Staffing- Directing- Controlling
3. Explain the Delegation of authority – responsibility – accountability

Course Outcome 3 (CO3):

1. Choose the Self-managing work teams -Intergroup – Conflict in organizations
2. Write the Leadership-Engineer as Manager –aspects of decision making
3. Discuss the Significance of human relation and organizational

Course Outcome 4 (CO4):

1. Explain the Current trends in compensation
2. Write the Job evaluation – Incentives- Practices in Indian organisations - Statutory benefits - non-statutory (voluntary) benefits
3. Discuss the Insurance benefits - retirement benefits and other welfare measures to build employee commitment

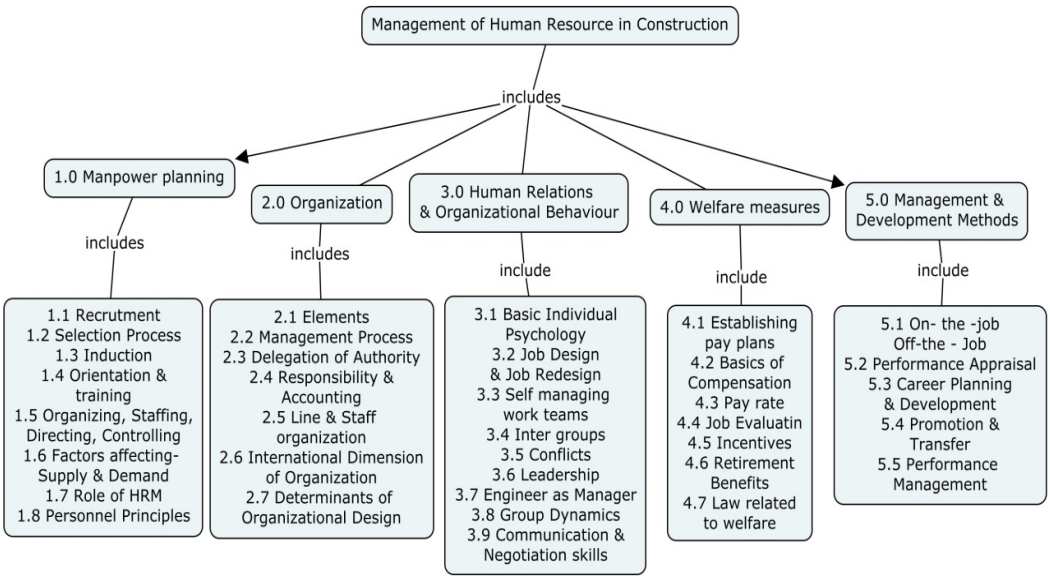
Course Outcome 5 (CO5):

1. Write the On-the-job Management Developments
2. Write the OFF-the-job Management Developments
4. Explain Performance appraisal in practice.

Course Outcome 6 (CO6):

1. Explain Developing policies, practices and establishing process pattern
2. Write the Competency upgradation and their assessment
3. Discuss New methods of training and development

Concept Map



Syllabus

MANPOWER PLANNING - Manpower planning and forecasting – Recruitment, selection process-Sources- Induction- Orientation and Training -Manpower Planning process - Organising, Staffing, directing, and controlling — Factors influencing supply and demand of human resources

– Role of HR manager – Personnel Principles. **ORGANISATION** Elements of an organisation- Management process in organisations- Planning-Organising-Staffing- Directing- Controlling – Delegation of authority – responsibility – accountability – lines and staff organisation Workforce diversity- international dimensions of Organisation- Organisational structure- determinants of organisational design. **HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR -** Basic individual psychology – Approaches to job design and job redesign – Self managing work teams – Intergroup – Conflict in organizations – Leadership-Engineer as Manager –aspects of decision making – Significance of human relation and organizational – Individual in organization – Motivation – Personality and creativity – Group dynamics, Team working – Communication and negotiation skills. **WELFARE MEASURES** - Establishing Pay plans - Basics of compensation - factors determining pay rate - Current trends in compensation - Job evaluation – Incentives- Practices in Indian organisations - Statutory benefits - non-statutory (voluntary) benefits - Insurance benefits - retirement benefits and other welfare measures to build employee commitment – Laws related to welfare measures. **MANAGEMENT AND DEVELOPMENT METHODS -** Management Development - On-the-job and off-the-job- Management Developments - Performance appraisal in practice. Managing careers: Career planning and development - Managing promotions and transfers. of operations – Developing policies, practices and establishing process pattern – Competency upgradation and their assessment – New methods of training and development – Performance Management.

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1. Charles D Pringle, Justin GooderiLongenecter, Management, CE Merril Publishing Co. 2001.
2. Dwivedi R.S, Human Relations and OrganisationalBehaviour, Macmillian India Ltd.,2005. 3. Josy .J, Familaro, “Handbook of Human Resources Administration”, McGraw-Hill Intemational Edition, 2007
4. D. Longford M.R. Hancock, R. Rellows& A. W. Gale, Human Recourse Management In Construction.– Longman Group Limited , fourth impression 2000.
5. Carleton Counter II and Jill Justice Coulter, “The Complete Standard Hand Book of Construction Personnel Management ", Prentice Hall, Inc., New Jersey, 1989.

Course Contents and Lecture Schedule

Module No	Topics	No.of Lectures	COs
1.0	**MANPOWER PLANNING**		
1.1	Manpower planning and forecasting	1	CO1
1.2	Recruitment, selection process- Induction- Orientation and Training	1	CO1
1.3	Manpower Planning process - Organising, Staffing, directing, and controlling	2	CO1
1.4	Factors influencing supply and demand of human resources	1	CO1
1.5	Role of HR manager – Personnel Principles	1	CO1
2.0	**ORGANISATION**		
2.1	Elements of an organisation- Management process in organisations	1	CO2
2.2	Planning-Organising-Staffing- Directing- Controlling	2	CO2
2.3	Delegation of authority – responsibility – accountability	2	CO2
2.4	lines and staff organisation Workforce diversity	2	CO2
2.5	International dimensions of Organisation	1	CO2
2.6	Organisational structure- determinants of organisational design	1	CO2

3.0	**HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR**		
3.1	Basic individual psychology	1	CO3
3.2	Approaches to job design and job redesign	2	CO3
3.3	Self-managing work teams -Intergroup – Conflict in organizations	1	CO3
3.4	Leadership-Engineer as Manager –aspects of decision making	1	CO3
3.5	Significance of human relation and organizational	1	CO3
3.6	Individual in organization – Motivation – Personality and creativity	1	CO3
3.7	Team working – Communication and negotiation skills	1	CO3
4.0	**WELFARE MEASURES**		
4.1	Establishing Pay plans - Basics of compensation	1	CO4
4.2	Factors determining pay rate	2	CO4
4.3	Current trends in compensation	1	CO4
4.4	Job evaluation – Incentives- Practices in Indian organisations - Statutory benefits - non-statutory (voluntary) benefits	1	CO4
4.5	Insurance benefits - retirement benefits and other welfare measures to build employee commitment –	1	CO5
4.6	Laws related to welfare measures	1	CO5
5.0	**MANAGEMENT AND DEVELOPMENT METHODS**		
5.1	On-the-job and off-the-job- Management Developments	1	CO5
5.2	Performance appraisal in practice.	1	CO5
5.3	Managing careers: Career planning and development	1	CO6
5.4	Managing promotions and transfers. of operations	1	CO6
5.5	Developing policies, practices and establishing process pattern – Competency upgradation and their assessment –	1	CO6
5.6	New methods of training and development – Performance Management	1	CO6

Course Designers:

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22CMPD0	ADVANCED CONCRETE TECHNOLOGY	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making concrete.

Prerequisite

Basics of Concrete Technology

Course Outcomes

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

COs	Course Outcome Statement	Bloom's Level
CO1	Discuss the properties of various materials needed for concrete manufacture as per codal provisions	Understand
CO2	Design concrete mix proportions based on various standards	Apply
CO3	Illustrate the methods of manufacturing, properties and applications of various concretes	Apply
CO4	Choose appropriate special concretes for different applications	Apply
CO5	Enumerate tests on fresh concrete along with limitations	Understand
CO6	Discuss various destructive and non- destructive tests on hardened concrete with limitations	Understand

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	S	S		---	L	M	M	M	L	L	M	M
CO3.	S	M	M	----	---	M	M	L	L	L	M	L	M
CO4.	S	S	M	L	---	L	M	L	L	M	M	L	S
CO5.	S	M	L	M	---	M	L	L	L	S	L	L	S
CO6	L	---	M	---	---	L	M	M	M	M	L	M	M

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Enumerate the Aggregates classification according to IS Specifications
2. Write the Properties, Grading, Methods of combining aggregates, specified gradings
3. Explain the Testing of aggregates.

Course Outcome 2 (CO2):

1. Enumerate the Principles of concrete mix design and Methods of concrete mix design using IS Method
2. Write the Principles of concrete mix design and Methods of concrete mix design using ACI Method
3. Explain the Mix design for special concretes- changes in Mix design for special materials

Course Outcome 3 (CO3):

1. Enumerate the Process of manufacturing of concrete.
2. Discuss the methods of transportation, placing and curing
3. Explain Extreme weather concreting, special concreting methods.

Course Outcome 4 (CO4):

1. Explain the Light weight concrete
2. Discuss Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete,
3. Explain Geo Polymer Concrete, Waste material-based concrete – Ready mixed concrete

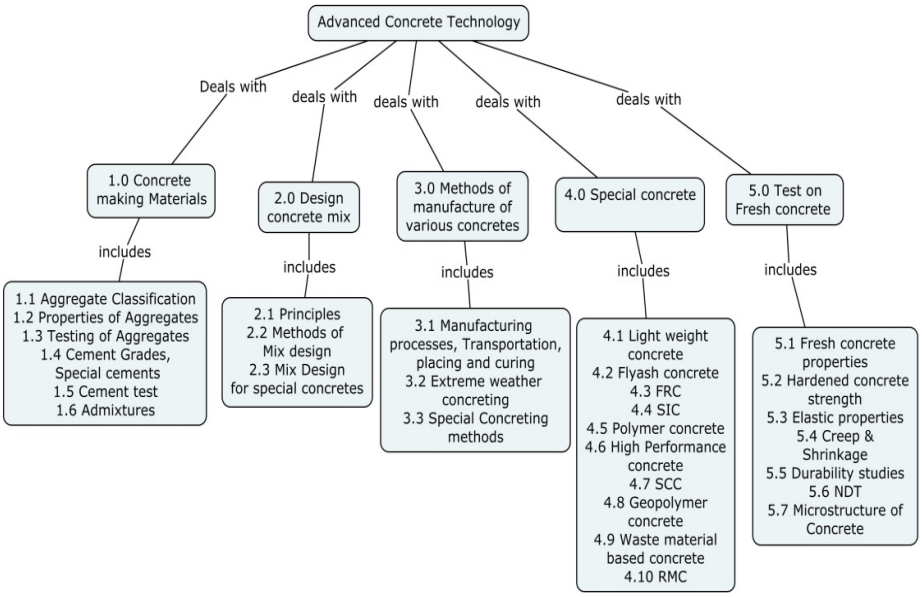
Course Outcome 5 (CO5):

3. Write the Properties of fresh concrete
4. Discuss Creep and shrinkage
4. Explain Durability of concrete

Course Outcome 6 (CO6):

4. Explain the properties of Hardened concrete
5. Enumerate Non-destructive Testing Techniques
6. Discuss microstructure of concrete.

Concept Map



Syllabus

Concrete making materials Aggregates classification IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, special cements. Water Chemical admixtures, Mineral admixture. **Mix Design** Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – Mix design for special concretes- changes in Mix design for special materials. **Concreting Methods** Process of manufacturing of concrete, methods of transportation, placing and curing, Extreme weather concreting, special concreting methods. Vacuum dewatering – Underwater Concrete. **Special Concretes** Light weight concrete Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete – High performance concrete. High performance fibre reinforced concrete, Self- Compacting-Concrete, Geo Polymer Concrete, Waste material-based concrete – Ready mixed concrete. **Tests on Concrete** Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage – Durability of concrete. Non-destructive Testing Techniques microstructure of concrete.

Reference Books

1. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
2. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2003.
5. Job Thomas., Concrete Technology, Cencage learning India Private Ltd, New Delhi, 2015.

Course Contents and Lecture Schedule

Module No	Topics	No.of Lectures	COs
1.0	**Concrete making materials**		CO1
1.1	Aggregates classification IS Specifications, Properties,	1	CO1
1.2	Grading, Methods of combining aggregates, specified gradings,	1	CO1
1.3	Testing of aggregates.	2	CO1
1.4	Cement, Grade of cement, Chemical composition,	1	CO1
1.5	Testing of cement	1	CO1
1.6	Hydration of cement, Structure of hydrated cement, special cements	2	CO1
1.7	Chemical admixtures and Mineral admixture	1	CO1
2.0	**Mix Design**		CO2
2.1	Principles of concrete mix design	1	CO2
2.2	IS Method of concrete mix design	1	CO2
2.3	ACI Method of concrete mix design	1	CO2
2.4	DOE Method of concrete mix design	1	CO2
2.5	Mix design for special concretes-	2	CO2
2.6	Changes in Mix design for special materials	1	CO2
3.0	**Concreting Methods**		
3.2	Process of manufacturing of concrete,	1	CO3
3.3	Methods of transportation, placing and curing,	1	CO3
3.4	Extreme weather concreting	1	CO3
3.5	Special concreting methods	1	CO3
4.0	**Special Concretes**		
4.1	Light weight concrete, High Volume Fly ash concrete	1	CO4
4.2	Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete	2	CO4

4.3	High performance concrete, High performance fibre reinforced concrete,	2	CO4
4.4	Self- Compacting-Concrete, Geo Polymer Concrete,	1	CO4
4.5	Waste material-based concrete	1	CO4
4.6	Ready mixed concrete	1	CO4
5.0	**Tests on Concrete**		
5.1	Properties of fresh concrete,	2	CO5
5.2	Properties of Hardened concrete, Strength, Elastic properties	2	CO5
5.3	Test on Creep and shrinkage	1	CO5
5.4	Durability properties of concrete.	1	CO5
5.5	Non-destructive Testing Techniques	1	CO6
5.6	Microstructure of concrete	1	CO6

Course Designer

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22CMPE0	**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	Course Outcome Detail (COs)	Bloom's Level
CO1	Understand the necessity to study the impacts that will be caused by projects or industries and the methods to assess these impacts	Understand
CO2	Describe the legal requirements of environmental impact assessment for projects	Understand
CO3	Prepare terms of reference for environmental impact and socio-economic impact for any developmental project	Apply
CO4	Prepare environmental management plan and risk mitigation plan by considering environmental aspects, impacts and potential hazards respectively for any project	Apply
CO5	Analyze the environmental impactsspecified in the EIA	Apply
CO6	Report and suggest suitable mitigation measures for any developmental projects	Apply

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
CO6	M	L	L	M	---	S	---	L	M	M	L	S	M

S- Strong; M-Medium;L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the role of Public Participation in Environmental Decision Making.
2. EIA is an effective management tool : comment
3. Explain the various methodologies adapted for prediction of impacts for EIA report

Course Outcome 2 (CO2):

4. Explain the legal framework for getting environment clearance for new projects.
5. Describe the procedure for conducting the public hearing as per EIA notification2006.
6. Explain the legal framework for handling hazardous waste generated from anyindustry.

Course Outcome 3 (CO3):

1. Prepare terms of reference for coal based Thermal Power Plant having a capacity of 2x330 MW which is located at Nagapattinam district.
2. In Madurai it is propose to develop a CETP for 20 Electroplating units. Identify the potential impacts of the project and prescribe suitable terms of reference for the project.
3. It is proposed to construct a large hydro-electric power project at the foot hills of Varusanaadu. Prepare terms of reference for the socio-economic impacts.

Course Outcome 4 (CO4):

1. Pudur is a town located along the OMR road. It is proposed to construct 6000 No.of residential houses in that area. Identify the potential impacts of the project and suggest a management plan to mitigate them.
2. Write the impacts and potential hazards for Mining project.
3. Analyze and suggest the Resettlement & Rehabilitation measures for a Dam construction project.

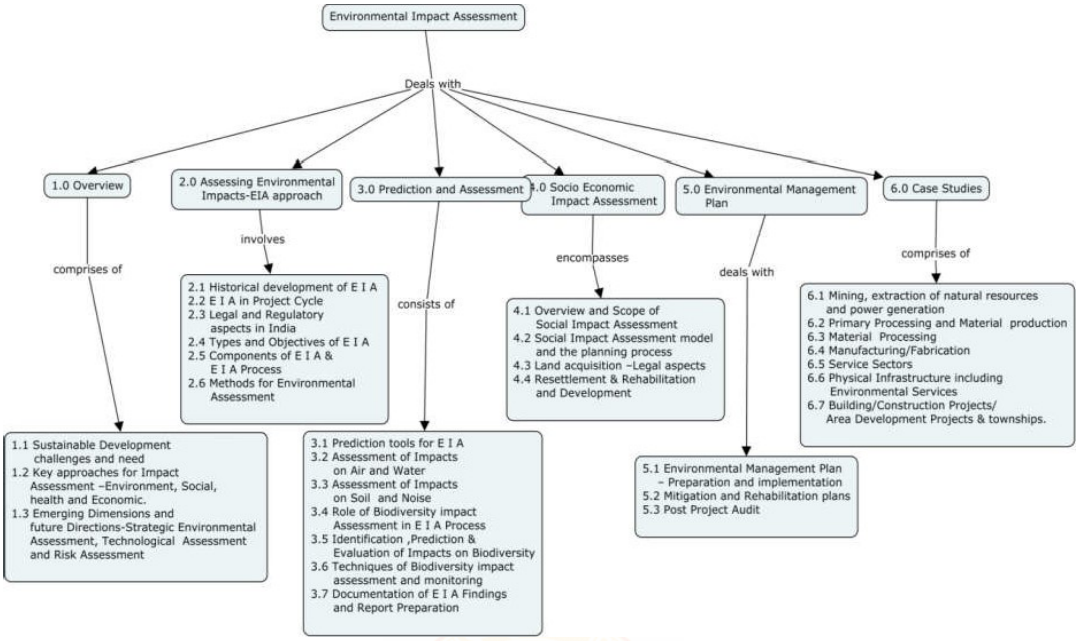
Course Outcome 5 (CO5):

1. Sabarimalai is a pilgrimage town located in Kerala state. It is proposed to develop a Greenfield airport project for the capacity to handle six new generation large aircraft. Identify the potential impacts of the project and suggest a management plan to mitigate them.
2. The extension of Madurai International Brownfield airport project is proposed to handle the passenger fleet. Prepare the management plan to identify the risk involved in the project.
3. Discuss the post project audit process in Area Development Projects & townships.

Course Outcome 6 (CO6):

1. Prepare risk assessment report for a stand-alone distillery unit having a capacity of 50 klpd. The raw material is sugarcane based molasses. Identify the potential impacts.
2. Prepare the mitigation plan for the above scenario.
3. Identify the potential impacts in the power generation project.

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. Canter, L.W., “Environmental Impact Assessment”, McGraw Hill, New York, 1996.
2. Anjaneyulu, Yerramilli, and Valli Manickam, “Environmental impact assessment methodologies”, Hyderabad: BS Publications, 2007.
3. Lawrence, D.P., “Environmental Impact Assessment – Practical Solutions to recurrentproblems”, Wiley-Interscience, New Jersey, 2003.

4. Petts, J., "Handbook of Environmental Impact Assessment', Vol., I and II, Blackwellscience, 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	Period	COs
1.0 OVER VIEW			
1.1	Sustainable Development challenges and need	2	CO1
1.2	Key approaches for Impact Assessment –Environment, Social, health and Economic.	1	CO1
1.3	Emerging Dimensions and future Directions-Strategic Environmental Assessment, Technological Assessment and Risk Assessment	2	CO1
2.0 ASSESSING ENVIRONMENTAL IMPACTS-E I A APPROACH			
2.1	Historical development of E I A	1	CO2
2.2	E I A in Project Cycle	1	CO2
2.3	Legal and Regulatory aspects in India	1	CO2
2.4	Types and Objectives of E I A	1	CO2
2.5	Components of E I A & E I A Process	2	CO2
2.6	Methods for Environmental Assessment	2	CO2
3.0 PREDICTION AND ASSESSMENT			
3.1	Prediction tools for E I A	2	CO3
3.2	Assessment of Impacts on Air and Water	1	CO3
3.3	Assessment of Impacts on Soil and Noise	1	CO3
3.4	Role of Biodiversity impact Assessment in E I A Process	1	CO3
3.5	Identification ,Prediction &Evaluation of Impacts on Biodiversity	1	CO3
3.6	Techniques of Biodiversity impact assessment and monitoring	2	CO3
3.7	Documentation of E I A Findings and Report Preparation	1	CO3
4.0 SOCIO-ECONOMIC IMPACT ASSESSMENT			
4.1	Overview and Scope of Social Impact Assessment	1	CO4
4.2	Social Impact Assessment model and the planning process	1	CO4
4.3	Land acquisition –Legal aspects	1	CO4
4.4	Resettlement & Rehabilitation and Development	1	CO4
5.0 ENVIRONMENTAL MANAGEMENT PLAN			
5.1	Environmental Management Plan – Preparation and	1	CO5
5.2	Mitigation and Rehabilitation plans	1	CO6
5.3	Post Project Audit	1	CO6

Course Designers

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		Category	L	T	P	Credit
22CMPF0	**REPAIR AND REHABILITATION OF STRUCTURES**	PE	3	0	0	3

Preamble

This course covers the subject starting from causes of deterioration; investigate methods, design principles, selection criteria of repair materials & methods, guidelines for repair and rehabilitation of structures

Prerequisite

Building Services, Concrete Technology

Course Outcomes

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

COs	Course Outcome Statement	Bloom's Level
CO1	Explain the importance of maintenance assessment of distressed structures	Understand
CO2	Formulate Quality assurance scheme for concrete based on Strength and Durability aspects	Apply
CO3	Diagnosis of distressed structures and identify causes of failures	Apply
CO4	Choose appropriate repair materials for treatment of distressed concrete structures	Apply
CO5	Apply the knowledge on Concrete protection methods Structural health monitoring to given situations	Apply
CO6	Select strengthening and repair methods for different distressed structures	Apply

Assessment Pattern

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

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	S	M	L	L	L
CO2	M	L	-	-	-	M	-	-	-	M	M	L	L	L
CO3	S	M	L	-	-	-	-	M	M	M	M	M	L	L
CO4	S	M	L	L	-	M	M	M	L	M	M	M	L	M
CO5	S	M	L	M	-	M	M	M	-	S	M	M	M	M
CO6	S	M	L	M	-	M	M	M	-	S	M	M	M	M

Strong; M-Medium; L-Low

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the need for Repair and Rehabilitation.
2. Write the Importance of Maintenance.
3. Explain the causes of deterioration.

Course Outcome 2 (CO2):

1. Enumerate the process for Quality assurance for concrete based on Strength and Durability.
2. Write the Thermal properties, microstructure of concrete.
3. Explain the packing density- Cracks, different types,

Course Outcome 3 (CO3):

1. Write the Criteria for material selection, Methodology of selection
2. Write the Advantages of Special mortars and concretes
3. Discuss Grouting materials

Course Outcome 4 (CO4):

1. Explain the Concrete protection methods
2. Write the reinforcement protection methods
3. Discuss the Corrosion protection techniques

Course Outcome 5 (CO5):

1. Write the use of Corrosion inhibitors
2. Discuss Types of Structural health monitoring.
3. Explain Coatings to reinforcement

Course Outcome 6 (CO6):

1. Explain Flexural strengthening.
2. Write the Beam shear strengthening
3. Discuss Stages of corrosion damage

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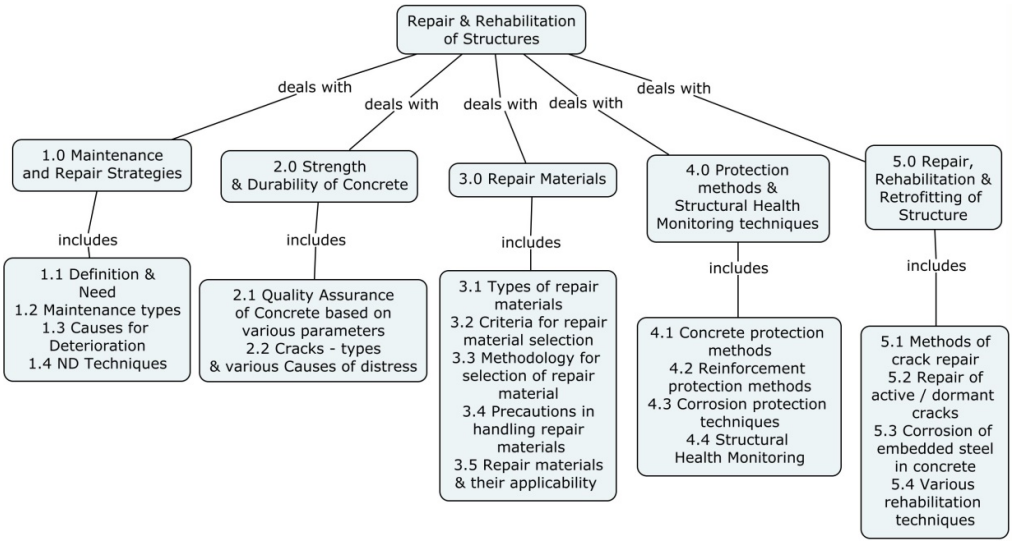
Concept Map



Syllabus

Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, retrofit and strengthening, need for rehabilitation of structures Facets of Maintenance, importance of Maintenance, routine and preventive maintenance, causes of deterioration. Non-destructive Testing Techniques. **Strength and Durability of Concrete** Quality assurance for concrete based

on Strength and Durability - Thermal properties, microstructure of concrete – packing density- Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion. **Repair Materials** Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Health and safety precautions for handling and applications of repair materials, Special mortars and concretes- Polymer Concrete and Mortar, Quick setting compounds, Grouting materials-Gas forming grouts, Salfoalumate grouts, Polymer grouts, Acrylate and Urethane grouts, Bonding agents-Latex emulsions, Epoxy bonding agents, Protective coatings-Protective coatings for Concrete and Steel, FRP sheets**. Protection Methods and Structural Health Monitoring** Concrete protection methods – reinforcement protection methods- Corrosion protection techniques – Corrosion inhibitors, concrete coatings-Corrosion resistant steels, Coatings to reinforcement, cathodic protection. Structural health monitoring. **Repair, Rehabilitation and Retrofitting of Structures** Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Overlays, Repair to active cracks, Repair to dormant cracks. Corrosion of embedded steel in concrete, Mechanism, Stages of corrosion damage, Repair of various corrosion damaged of structural elements (slab, beam and columns) Jacketing, Column jacketing, Beam jacketing, Beam Column joint jacketing, reinforced concrete jacketing, Steel jacketing, FRP jacketing, Strengthening, Beam shear strengthening, Flexural strengthening.

Reference Books

1. Dodge Woodson, Concrete Structures, Protection, Repair and Rehabilitation, Butterworth- Heinemann, Elsevier, New Delhi 2012
2. DovKominetzky. M.S., - Design and Construction Failures, Galgotia Publications Pvt.Ltd.,2001
3. Ravishankar.K., Krishnamoorthy.T.S, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.
4. Hand book on Seismic Retrofit of Buildings, CPWD and Indian Buildings Congress, Narosa Publishers, 2008.
5. Hand Book on “Repair and Rehabilitation of RCC Buildings” – Director General works CPWD ,Govt of India , New Delhi – 2002

Course Contents and Lecture Schedule

Module No	Topics	No.of Lectures	COs
1.0	**Maintenance and Repair Strategies**		
1.1	Strategies Maintenance, Repair and Rehabilitation, retrofit and strengthening,	1	CO1
1.2	Need for rehabilitation of structures Facets of Maintenance,	1	CO1
1.3	Importance of Maintenance	1	CO1
1.4	Routine and preventive maintenance,	1	CO1
1.5	Causes of deterioration	1	CO1
1.6	Non-destructive Testing Techniques	2	CO1
2.0	**Strength and Durability of Concrete**		
2.1	Quality assurance for concrete based on Strength and Durability -	2	CO2
2.2	Thermal properties of concrete	1	CO2
2.3	microstructure of concrete – packing density	1	CO2
2.4	Cracks, different types, causes of cracks	1	CO3
2.5	Effects due Corrosion to climate, temperature, Sustained elevated temperature	2	CO3
2.6	Corrosion	1	CO3
3.0	**Repair Materials**		
3.1	Repair materials-Various repair materials, Criteria for	1	CO4

	material selection, Methodology of selection,		
3.2	Health and safety precautions for handling and applications of repair materials,	1	CO4
3.3	Special mortars and concretes- Polymer Concrete and Mortar, Quick setting compounds,	1	CO4
3.4	Grouting materials-Gas forming grouts, Salfoalumate grouts, Polymer grouts, Acrylate and Urethane grouts,	2	CO4
3.5	Bonding agents-Latex emulsions, Epoxy bonding agents	1	CO4
3.6	Protective coatings-Protective coatings for Concrete and Steel, FRP sheets	1	CO4
4.0	**Protection Methods and Structural Health Monitoring**		
4.1	Concrete protection methods	1	CO5
4.2	Reinforcement protection methods	1	CO5
4.3	Corrosion protection techniques – Corrosion inhibitors	1	CO5
4.4	Concrete coatings-Corrosion resistant steels	1	CO5
4.5	Coatings to reinforcement, cathodic protection	1	CO5
4.6	Structural health monitoring-case Studies	1	CO5
5.0	**Repair, Rehabilitation and Retrofitting of Structures**		
5.1	Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Overlays,	2	CO6
5.2	Repair to active cracks, Repair to dormant cracks.	1	CO6
5.3	Corrosion of embedded steel in concrete, Mechanism, Stages of corrosion damage, Repair of various corrosion damaged of structural elements (slab, beam and columns)	2	CO6
5.4	Jacketing, Column jacketing, Beam jacketing, Beam Column joint jacketing, ,	1	CO6
5.5	Reinforced concrete jacketing, Steel jacketing	1	CO6
5.6	FRP jacketing, Strengthening, Beam shear strengthening ,Flexural strengthening.	1	CO6

Course Designers

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22CMPG0	FINANACE MANAGEMENT IN CONSTRUCTION	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 Construction 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:

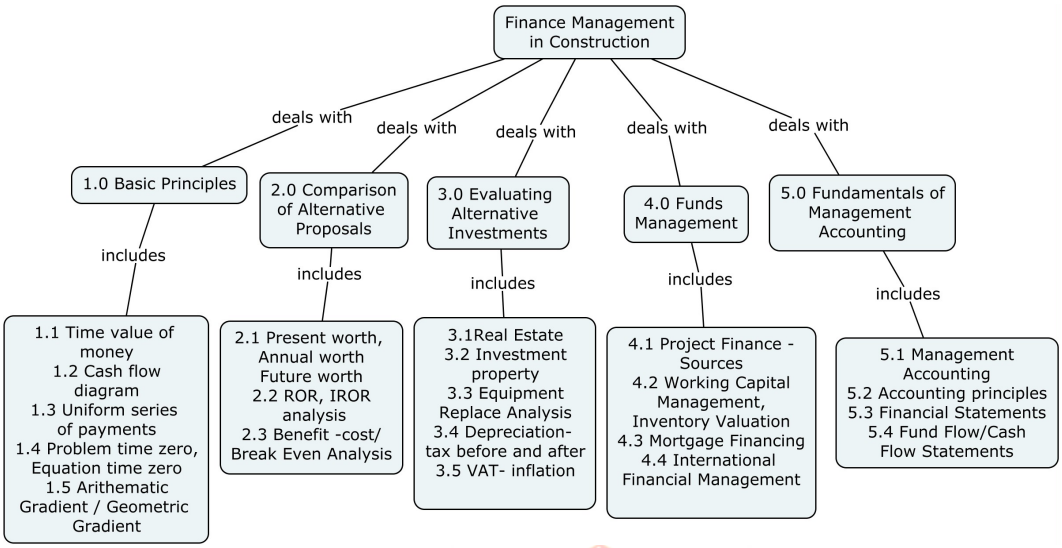
COs	Course Outcome	Bloom's Level
CO1	Understand the concept of Profit and Wealth Maximization Function.	Apply
CO2	Analysis of Statement of Changes in Financial Statement	Apply
CO3	Analysis of Break Even Point	Analyse
CO4	Analyse Cash Flow with Capital Budgeting Problem	Analyse
CO5	Analysis of Risk and Financial Leverage	Analyse
CO6	Determinants of Working Capital, Policy and Financing Policy	Analyse

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
CO6	S	S	S	L	---	---	S	---	M	---	L	M	M

Strong; M-Medium; L-Low

Concept Map



Assessment Pattern

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

Course Questions

CO1:

1. Illustrate profit maximation and wealth maximization
2. Explain the importance of Time Value of Money
3. How the finance function is organised in large construction company?

CO2

1. Discuss Present Worth Analysis of construction projects
2. From the following trial balance of Mr. Deshmuk& Sons Prepare Trading, Profit- Loss account as on the year end.

Particulars	Debit	Credit	Particulars	Debit	Credit
Opening Stock (01st April 2016)	27,000		Trade expense	800	
Purchase	26,750		Interest Paid	750	
Discount Allowed	1,500		Building	7,500	
Wages	7,500		Furniture	3,500	
Travelling Expenses	700		Debtor	4,250	
Commission paid	600		Creditor		2,100

Carriage Inward	350		Sales		55,725
Administrative expenses	125		Capital		27,000
Cash	3500		**Total**	**84,825**	**84,825**

Stock on 31st March 2017 was Rs.12,000

3. From the following particulars taken out from the books of Abdul Hanan & Co. You are required to prepare Trading and Profit-Loss Account and Balance Sheet as at December 31st, 2019

Particulars	Amount	Particulars	Amount	Particulars	Amount
Sundry Debtors	52,000	Insurance Premium (paid on 1.10.19)	2,400	Transportation in	6,430
Account Payable	22,000	Cash at Bank	6,200	Owner's Capital	20,000
Cash In hand	2,392	Machinery	24,000	Drawing	8,000
Furniture	3,500	Wages	23,600	Rent and Taxes	3,600
Motor Car	22,000	General Expenses	2,680	Prepaid Insurance	1800
Purchases	1,45,000	Carriage Inward	2,040	Motor Car Expenses	3,600
Sales	2,92,000	Carriage Outward	1,630	Equipment	2,508
Sales Return	2,600	Salaries	8,420	Opening Stock	11,400

Adjustments:

i) Closing Stock: Rs. 35,000
ii) Provision for doubtful debt at 5% of sundry debtor
iii) Depreciation furniture and machinery by 10%

Commission of Rs. 3,600 has been earned but not received till the closing of accounts

CO3

1. You are given the following data for the coming year for a factory.

   Budgeted output - 8,00,000 units;
   Fixed expenses - 40,00,000;
   Variable expenses per unit ` 100;
   Selling price per unit - 200;

   If price is reduced to ` 180, what will be the new break-even point?
2. Draw a break-even chart showing the break-even point for new and old breakeven points.
3. Enumerate the significance of Profit-Volume ratio

CO4:

1. Recite the importance of Capital budgeting

2. M/S Johnson limited is planning to by a automatic printing machine. The cash outlay and cashflow are given in the various proposals. Expected lifetime of the machine was 7 years. Net profit before depreciation and tax from the above investment proposals are given below. Depreciation is taken by Declining Balance method. Assume the tax rate as 22.5% and suggest the company to choose the correct proposal.

1. Analyze through i) Pay back period ii) Net Present Value iii)Internal Rate of Return
2. iv) Profitability Index. (Use Discounted Rate at 8.5%)
3. Along with that represent the cashflow in a graphical form so as to have the check in trend analysis and represent the cash flow is rising trend or falling trend.

Year	Cash flow before Tax and Depreciation (Amount are in Lakhs)	
	Proposal X	Proposal Y
Cash Outlay	42	48
1	10	15
2	12	19
3	16	21
4	18	26
Depreciation (in %)	12.5%	18%

3. Define cash flow taking an example of your choice

CO5:

1. Illustrate the concept of Venture Capital and discuss the risks associated with the venture capital
2. Define Capital Rationing
3. Illustrate the objectives of Financial Management and essential key factors to be considered for financial management

CO6:

1. Summarize the financial accounting principles
2. List and discuss any two management accounting principles
3. From the following Balance sheet of M/S Arvind Industries Limited as on 31st March 2021. calculate i) Liquidity Ratio ii)Profitability Ratio

Liabilities	Amount	Asset	Amount
Equity Share Capital	10,000	Fixed Asset	26,000
Preference Share Capital	2,000	**Current Assets**	
Reserves and Surplus	8,000	Cash	1,000
Mortgage Debentures	14,000	Investment	3,000
Current Liabilities		Sundry Debtor	4,000
Creditor	1,200	Stock	6,000
Bill Payable	2,000		
Outstanding Expenses	200		
Tax Provision	2,600		
	40,000		**40,000**

Additional Information:

i. Net Sales : Rs. 60,000
ii. Cost of Goods Sold :Rs. 51,600
iii. Net Income before Tax : Rs. 4,000
iv. Net Income After Tax : Rs.2,000

Give the brief classification of techniques adopted for financial analysis and explain about Trend analysis and represent it graphically.

Syllabus

Basic Principles - Time Value of Money – Cash Flow diagram – Nominal and effective interest-continuous interest. Single Payment Compound Amount Factor (P/F,F/P) – Uniform series of Payments (F/A,A/F,F/P,A/P)– Problem time zero (PTZ)- equation time zero (ETZ). Constant increment to periodic payments – Arithmetic Gradient(G), Geometric Gradient (C). **Comparing Alternatives Proposals** - Comparing alternatives- Present Worth Analysis, Annual Worth Analysis, Future Worth Analysis, Rate of Return Analysis (ROR) and Incremental Rate of Return (IROR)Analysis, Benefit/Cost Analysis, Break Even Analysis. **Evaluating Alternative Investments -** Real Estate - Investment Property, Equipment Replace Analysis, Depreciation – Tax before and after depreciation – Value Added Tax (VAT) – Inflation. **Funds Management -**

Project Finance – Sources of finance - Long-term and short -term finance, Working Capital Management, Inventory valuation, Mortgage Financing - International financial management foreign currency management. **Fundamentals of Management Accounting** - Management accounting, Financial accounting principles- basic concepts, Financial statements – accounting ratios - funds flow statement – cash flow statement

References

1. Blank, L.T., and Tarquin,a.J Engineering Economy,4th Edn. Mc-Graw Hill Book Co., 1988
2. Collier C and GlaGola C Engineering Economics & Cost Analysis, 3nd Edn. Addison Wesley Education Publishers.,1998.
3. Patel, B M Project management- strategic Financial Planning, Evaluation and Control, Vikas Publishing House Pvt. Ltd. New Delhi, 2000
4. Shrivastava,U.K., Construction Planning and Management,2nd Edn. Galgotia Publications Pvt. Ltd. New Delhi., 2001.
5. Steiner, H.M. Engineering Economic principles, 2nd Edn. McGraw Hill Book, 1996

Course Contents and Lecture Schedule

Module No	Topics	No.of Lectures
1.0	**Basic Principles**	
1.1	Time Value of Money – Cash Flow diagram –	
1.2	Nominal and effective interest- continuous interest.	
1.3	Single Payment Compound Amount Factor (P/F,F/P)	
1.4	Uniform series of Payments (F/A,A/F,F/P,A/P)	
1.5	Problem time zero (PTZ)- equation time zero (ETZ).	
1.6	Constant increment to periodic payments – Arithmetic Gradient(G), Geometric Gradient (C).	
2.0	**Comparing Alternatives Proposals**	
2.1	Comparing alternatives- Present Worth Analysis,	
2.2	Annual Worth Analysis, Future Worth Analysis,	
2.3	Rate of Return Analysis (ROR)	
2.4	Incremental Rate of Return (IROR)Analysis,	
2.5	Benefit/Cost Analysis	
2.6	Break Even Analysis	
3.0	**Evaluating Alternative Investments**	
3.1	Real Estate - Investment Property	
3.2	Equipment Replace Analysis	
3.3	Depreciation	
3.4	Tax before and after depreciation	
3.5	Value Added Tax (VAT)	
3.6	Inflation	
4.0	**Funds Management**	
4.1	Project Finance – Sources of finance	
4.2	Long-term and short -term finance	
4.3	Working Capital Management	
4.4	Inventory valuation	
4.5	Mortgage Financing	
4.6	International financial management foreign currency management	
5.0	**Fundamentals of Management Accounting**	
5.1	Management accounting	

5.2	Financial accounting principles- basic concepts,	
5.3	Financial statements	
5.4	Accounting ratios	
5.5	Funds flow statement	
5.6	Cash flow statement	

Course Designers :

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2. Mr.B.Dinesh Kumar bdkciv@tce.edu

22CMPH0 SUSTAINABLE CONSTRUCTION

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

To impart knowledge about sustainable construction and to understand the concepts of sustainable materials, energy calculations, green buildings and environmental effects.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	Bloom's Level
CO1	Describe the various sustainable materials used in construction.	Understand
CO2	Explain the method of estimating the amount of energy required for building.	Apply
CO3	Select the features of GRIHA rating of buildings.	Analyse
CO4	Select the features of LEED, TERI ratings of buildings.	Analyse
CO5	Explore the concept and performance of zero energy buildings.	Analyse
CO6	Select less carbon emission materials for construction applications.	Analyse

Mapping with Programme Outcomes

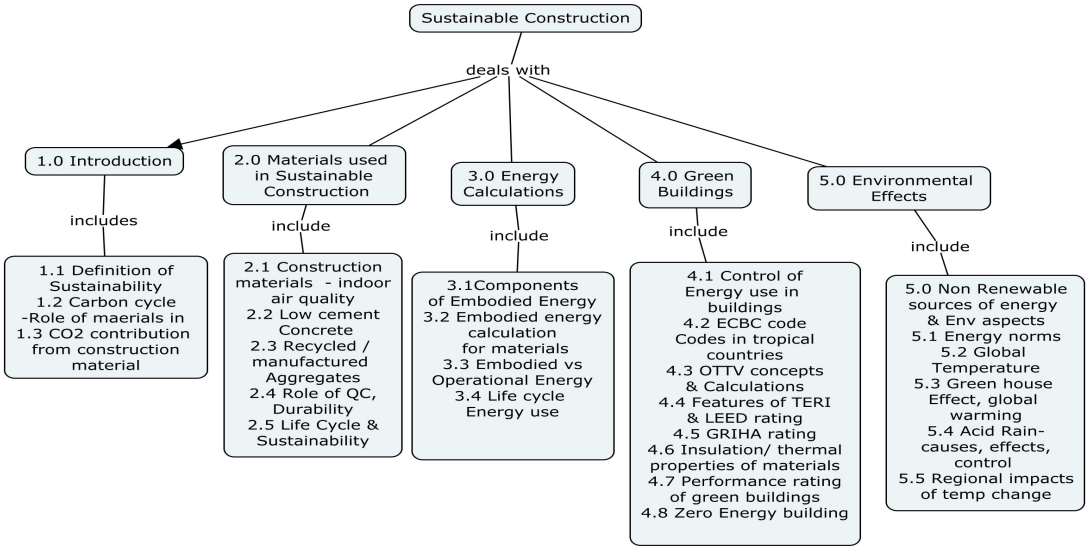
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	---	---	---	---	---	---	---	---	---	---	L	L
CO2	M	M	---	---	---	M	---	---	---	M	M	S	M
CO3	S	M	---	---	---	M	---	---	---	M	M	S	M
CO4	M	M	---	L	---	M	---	M	M	S	M	S	M
CO5	S	M	---	L	---	S	---	M	M	S	L	M	L
CO6	L	L	---	L	---	S	---	L	M	S	M	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Concept Map



Syllabus

Introduction: Introduction and definition of Sustainability - Carbon cycle - role of construction material: concrete and steel, etc. - CO_2 contribution from cement and other construction materials. **Materials used in sustainable construction:** Construction materials and indoor air quality - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Life cycle and sustainability. **Energy calculations:** Components of embodied energy - calculation of embodied energy for construction materials - Energy concept and primary energy - Embodied energy via-a-vis operational energy in conditioned building - Life Cycle energy use. **Green buildings:** Control of energy use in building - ECBC code, codes in neighboring tropical countries - OTTV concepts and calculations — Features of LEED and TERI — GRIHA ratings - Role of insulation and thermal properties of construction materials - influence of moisture content and modeling - Performance ratings of green buildings - Zero energy building. **Environmental effects:** Non-renewable sources of energy and Environmental aspects — energy norm, coal, oil, natural gas - Nuclear energy - Global temperature, Green house effects, global warming - Acid rain: Causes, effects and control methods - Regional impacts of temperature change.

References

1. Charles J Kibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition,Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment,Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee PublicationPvt. Ltd, 2012.
5. New Building Materials and Construction World magazine

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Introduction and definition of Sustainability	1
1.2	Carbon cycle	1
1.3	Role of construction material: concrete and steel, etc.	2
1.4	CO_2 contribution from cement and other construction materials	2
2.0	**Materials used in sustainable construction**	
2.1	Construction materials and indoor air quality	1
2.2	No/Low cement concrete	1
2.3	Recycled and manufactured aggregate	1
2.4	Role of QC and durability	1
2.5	Life cycle and sustainability	2
3.0	**Energy calculations**	
3.1	Components of embodied energy	1
3.2	calculation of embodied energy for construction materials	2
3.3	Energy concept and primary energy	1
3.4	Embodied energy via-a-vis operational energy in conditioned building	1
3.5	Life Cycle energy use	1
4.0	**Green buildings**	
4.1	Control of energy use in building - ECBC code, codes in neighbouring tropical countries	1
4.2	OTTV concepts and calculations	1
4.3	Features of LEED and TERI – GRIHA ratings	1
4.4	Role of insulation and thermal properties of construction materials - influence of moisture content and modelling	1
4.5	Performance ratings of green buildings	1
4.6	Zero energy building	1
5.0	**Environmental effects**	
5.1	Non-renewable sources of energy and Environmental aspects – energy norm, coal, oil, natural gas	**1**
5.2	Nuclear energy - Global temperature	**1**
5.3	Green house effects	**1**
5.4	Global warming	**1**
5.5	Acid rain: Causes, effects and control methods	**1**
5.6	Regional impacts of temperature change.	**1**
	Total hours	**36**

Course Designers

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22CMPJ0	MANAGEMENT INFORMATION SYSTEMS	Category	L	T	P	Credit
		PE	2	1	0	3

Preamble

To study the concepts of information systems and their applications, system development and information systems, implementation and control and system audit.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	Bloom's Level
CO1	Explain engineering fundamentals in various information systems in management.	Understand
CO2	Design the structured programs by computer-based methods.	Apply
CO3	Explain management information system for projects.	Understand
CO4	Perform the validation of the computer model and assess the risk of information system	Apply
CO5	Perform software quality assurance, verification and validation	Apply
CO6	Development of quality management system for an organization	Apply

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	S	M	---	---	---	M	---	---	---	M	M	S	M
CO4	M	M	---	L	---	M	---	M	M	S	M	S	M
CO5	S	M	---	L	---	S	---	M	M	S	L	M	L
CO6	L	L	---	L	---	S	---	L	M	S	M	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1(CO1):

1. Identify the framework of a Information System
2. Define MIS. Give an example
3. Develop a MIS for a construction project indicating the different types of information subsystems depending on functional areas.

Course Outcome 2(CO2):

1. What are structured Programs?
2. Describe the evolution of various computer based information systems.
3. Demonstrate the stages involved in traditional system life cycle development.

Course Outcome 3(CO3):

1. List the elements of effective safety programmes
2. Compare Integrated Construction Management Information System and Project Management Information System
3. Illustrate the types of knowledge representation in an Executive information system and expert system

Course Outcome 4(CO4):

1. Classify the errors encountered during data entry and how can they be resolved
2. Explain the methods of testing the security of the information systems.
3. Why Cost Benefit Analysis is carried out?

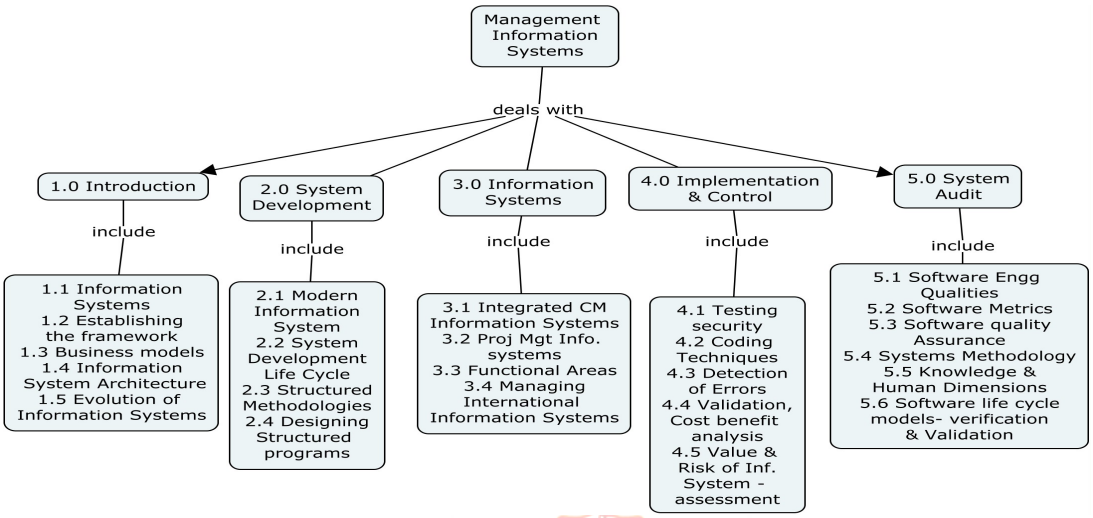
Course Outcome 5(CO5):

1. Mention the Software Engineering qualities
2. Discuss Software specification and Software Metrics
3. Make an overview of Software quality assurance in projects.

Course Outcome 6(CO6):

1. Write any two objectives of Systems Methodology
2. Highlight Software life cycle models and their salient features
3. Explain the Verification and Validation of systems and its software life cycle models.

Concept Map



Syllabus

Introduction - Information Systems – Establishing the Framework – Business Models – Information System Architecture – Evolution of Information Systems. **System Development -** Modern Information System – System Development Life Cycle – Structured Methodologies- Designing Computer Based Methods, Procedures, Control – Designing Structured Programs . **Information Systems** - Integrated Construction Management Information System – Project Management Information System – Functional Areas, Finance, Marketing, Production, Personnel – Levels, DSS, EIS, and ES – Comparison, Concepts and Knowledge Representation – Managing International Information System. **Implementation And Control** - Control – Testing Security – Coding Techniques – Defection of Error – Validating – Cost Benefit analysis – Assessing the value and risk of Information System. **System Audit** - Software Engineering qualities – Design, Production, Service, Software specification, Software Metrics, Software quality assurance – Systems Methodology – Objectives – Time and Logic, Knowledge and Human Dimension – Software life cycle models – Verification and Validation

References

1. Card and Glass, Measuring Software Design Quality , Prentice Hall, 1990.
2. Gordon B. Davis, Management Information System: Conceptual Foundations, Structure and Development, McGraw Hill, 1985.
3. Joyce J Elam, Case series for Management Information Systems , Simon and Schuster, Custom Publishing, 1996.
4. Kenneth C Laudon and Jane Price Laudon, Management Information Systems - Organisation and Technology, Prentice Hall, 2015.
5. Michael W. Evans and John J Marciniah, Software Quality assurance and Management, John Wiley and Sons, 1987

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Information Systems – Establishing the Framework	1
1.2	Business Models	1
1.3	Information System Architecture	2
1.4	Evolution of Information Systems	2
2.0	**System Development**	
2.1	Modern Information System	1
2.2	System Development Life Cycle	1
2.3	Structured Methodologies	1
2.4	Designing Computer Based Methods, Procedures, Control	2
2.5	Designing Structured Programs	1
3.0	**Information Systems**	
3.1	Integrated Construction Management Information System	1
3.2	Project Management Information System	1
3.3	Functional Areas, Finance, Marketing, Production, Personnel – Levels,	1
3.4	DSS, EIS, and ES – Comparison, Concepts and Knowledge Representation	2
3.5	Managing International Information System	1
4.0	**Implementation And Control**	
4.1	Control – Testing Security	1
4.2	Coding Techniques – Defection of Error – Validating	2
4.3	Cost Benefit analysis	2
4.4	Assessing the value and risk of Information System	1
5.0	**System Audit**	
5.1	Software Engineering qualities – Design, Production, Service	1
5.2	Software specification, Software Metrics, Software quality assurance	1
5.3	Systems Methodology – Objectives – Time and Logic,	1
5.4	Knowledge and Human Dimension	1
5.5	Software life cycle models	1
5.6	Verification and Validation	1
	Total hours	**36**

Course Designers:

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22CMPK0	DESIGN OF ENERGY EFFICIENT BUILDINGS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course aims to provide an understanding of the concept of energy consumption in buildings and design a energy efficient building

Course Outcomes

On the successful completion of the course, students will:

COs	Course Outcome Statements	Bloom's Level
CO1	Explain environmental energy supplies on buildings	Understand
CO2	Enumerate the effect of passive solar heating, cooling system	Apply
CO3	Apply the principles of day-lighting and electrical lighting in a building	Analyse
CO4	Predict and design building ventilation and heat control for indoor comfort	Analyse
CO5	Design a building for a prescribed climatic zone	Analyse
CO6	Apply simulation programs of buildings to perform energy calculations	Analyse

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
CO6	M	L	S	S	M	M	M	L	L	L	L	S	M

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define sustainability and its importance in construction
2. Write salient features of Greenhouse Effect – Convection – Measuring latent and sensible heat
3. Explain Types of Shading Devices

Course Outcome 2 (CO2):

1. Write a note on General Principles of passive Solar Heating
2. Discuss Codal requirements for Daylighting design
3. Explain Electric Lighting control for day lighted buildings.

Course Outcome 3 (CO3):

1. Explain General Principles of passive Solar Heating
2. Write Key Design Elements of Sunspace, Direct gain, Trombe Walls, Water Walls
3. Discuss Convective Air loops — Concepts apertures

Course Outcome 4 (CO4):

4. Minimum standardsfor ventilation – Ventilation Design
5. Explain Energy Conservation in Ventilating systems
6. Design for Natural Ventilation – Calculation of probable indoor wind speed.

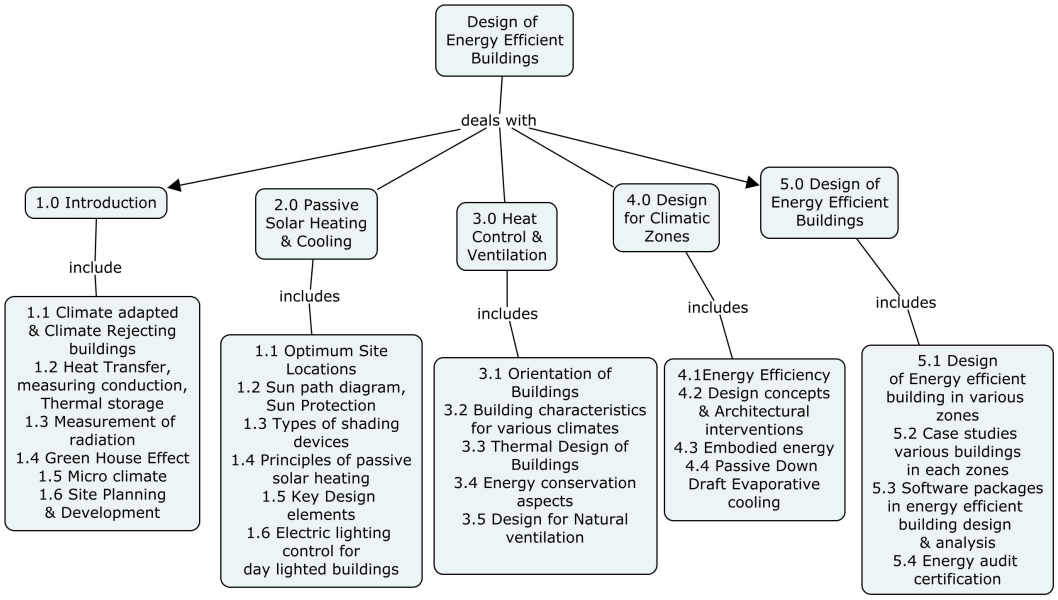
Course Outcome 5 (CO5):

1. Enumerate Energy efficiency – An Overview of Design Concepts and Architectural Interventions
2. Explain EmbodiedEnergy – Low Embodied Energy Materials
3. Discuss Passive Downdraft Evaporative Cooling

Course Outcome 6 (CO6):

1. Explain building conditions in Cold and cloudy – Cold and sunny – Composite –Hot and dry – Moderate – Warm and humid
2. Write the software packages in energy efficient buildinganalysis and design
3. Discuss Energy Audit – Certification.

Concept Map



Syllabus

Introduction: Climate adapted and climate rejecting buildings – Heat Transfer – Measuring Conduction – Thermal Storage – Measurement of Radiation – The Greenhouse Effect – Convection – Measuring latent and sensible heat – Psychrometry Chart – Thermal Comfort – Microclimate, Site Planning and Development — Temperature — Humidity — Wind — Optimum Site Locations — Sun Path Diagrams — Sun Protection — Types of Shading Devices — Design responses to energy conservation strategies. **Passive solar heating and cooling:** General Principles of passive Solar Heating – Key Design Elements – Sunspace – Direct gain – Trombe Walls, Water Walls — Convective Air loops — Concepts — Case Studies — Daylight apertures — Light Shelves — Codal requirements — Day lighting design – Electric Lighting – Light Distribution – Electric Lighting control for day lighted buildings**. Heat control and ventilation**: Orientation of buildings – Building characteristics for various climates – Thermal Design of buildings – Influence of Design Parameters – Mechanical controls – Examples. Ventilation – Requirements – Minimum standards for ventilation – Ventilation Design – Energy Conservation in Ventilating systems – Design for Natural Ventilation – Calculation of probable indoor wind speed**. Design for climatic zones**: Energy efficiency – An Overview of Design Concepts and Architectural Interventions – Embodied Energy – Low Embodied Energy Materials – Passive Downdraft Evaporative Cooling – **Design of Energy Efficient Buildings for Various Zones** – Cold and cloudy – Cold and sunny – Composite – Hot and dry – Moderate – Warm and humid – Case studies of residences, office buildings and other buildings in each zones – Commonly used software packages in energy efficient building analysis and design - Energy Audit — Certification.

References

1. Energy Conservation Building Code, Bureau of Energy Efficiency, New Delhi, 2018.
2. Handbook on Functional Requirements of Buildings Part 1 to 4 SP : 41 (S and T) 1995
3. Residential Energy: Cost Savings and Comfort for Existing Buildings by John Krigger and Chris Dorsi, Published by Saturn Resource Management, 2013.
4. Brown, G.Z. and DeKay, M., Sun, Wind and Light - Architectural Design Strategies, John Wiley and Sons Inc, 3rd Edition, 2014
5. Majumdar, M (Ed), Energy - Efficient Buildings in India, Tata Energy Research Institute, Ministry of Non-Conventional Energy Sources, 2009.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Climate adapted and climate rejecting buildings – Heat Transfer – Measuring Conduction	1
1.2	Thermal Storage – Measurement of Radiation – The Greenhouse Effect – Convection	1
1.3	Measuring latent and sensible heat – Psychrometry Chart – Thermal Comfort	1
1.4	Microclimate, Site Planning and Development – Temperature – Humidity – Wind – Optimum Site Locations	1
1.5	Sun Path Diagrams – Sun Protection	1
1.6	Types of Shading Devices – Design responses to energy conservation strategies	1

2.0	**Passive solar heating and cooling**	
2.1	General Principles of passive Solar Heating – Key Design Elements – Sunspace –	1
2.2	Direct gain – Trombe Walls, Water Walls –	1
2.3	Convective Air loops – Concepts – Case Studies –	1
2.4	Daylight apertures – Light Shelves – Codal requirements –	1
2.5	Day lighting design – Electric Lighting – Light Distribution –	1
2.6	Electric Lighting control for day lighted buildings	**1**
3.0	**Heat control and ventilation**	
3.1	Orientation of buildings – Building characteristics for various climates	1
3.2	Thermal Design of buildings – Influence of Design Parameters – Mechanical controls – Examples	1
3.3	Ventilation – Requirements – Minimum standards for ventilation	1
3.4	Ventilation Design – Energy Conservation in Ventilating systems	1
3.5	Design for Natural Ventilation	1
3.6	Calculation of probable indoor wind speed.	1
4.0	**Design for climatic zones**	
4.1	Energy efficiency – An Overview of Design Concepts and Architectural Interventions	2
4.2	Embodied Energy	1
4.3	Low Embodied Energy Materials	2
4.4	Passive Downdraft Evaporative Cooling	1
5.0	**Passive Downdraft Evaporative Cooling**	
5.1	Cold and cloudy – Cold and sunny – Composite	1
5.2	Hot and dry – Moderate – Warm and humid	1
5.3	Case studies of residences, office buildings and other buildings in each zone	1
5.4	Commonly used software packages in energy efficient building analysis and design	1
5.5	Energy Audit – Certification	2
	Total hours	**36**

Course Designers

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22CMPL0	ORGANIZATIONAL BEHAVIOUR	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To gain a solid understanding of human behaviour in the workplace from an individual, group, and organizational perspective and frameworks and tools to effectively analyze and approach various organizational situations.

Course Outcomes

On the successful completion of the course, students will:

COs	Course Outcome Statements	Bloom's Level
CO1	Identify the need and importance of organizational behavior and the framework of organizational models	Understand
CO2	Explain the various learning theories of organizational behaviour	Understand
CO3	Develop alternative organizational behavior approaches in the workplace	Apply
CO4	Describe the importance of group dynamics and team building.	Apply
CO5	Explore the various leadership styles and politics.	Apply
CO6	Apply the dynamics of organization behaviour with balance of work life.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	---	---	L	---	M	L	M	---	---	---	M	L
CO2	S	L	---	L	---	M	M	M	---	S	M	S	M
CO3	S	M	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
CO6	S	L	M	L	---	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	
Remember	10	20	20
Understand	30	20	20
Apply	60	60	60
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1(CO1):

1. "Organizational theories should follow the contingency approach". Discuss and
   Comment on the accuracy of this statement.
2. Define Organizational Behaviour. Mention its need for study in an industry
3. Discuss how globalization influences organizational behavior

Course Outcome 2 (CO2):

1. After few months on a job, Mr.X has experienced several emotional episodes ranging from frustration to joy about work he has been assigned. Use the attitude model to explain how these emotions affects Mr.X's level of job satisfaction with the work itself
2. "Happy employees create happy customers", Discuss.
3. Describe the dimensions of emotional intelligence

Course Outcome 3 (CO3):

1. Find two newspaper ads for management or executive positions. What leadership competencies are mentioned in these ads? If you were on the selection panel, what methods would you use to identify these competencies in job applicants?
2. List the elements of Lewin's force field analysis model
3. Explain how personality relates to Holland's model of vocational choice

Course Outcome 4 (CO4):

1. Identify the five types of individual behavior in organizations
2. A steel industry redesigned its production facilities around a team-based system. However the president of the industry believes that employees will not be motivated unless they receive incentives based on their individual performance. Give explanations why the industry should introduce team-based rather than individual rewards in this setting.
3. Differentiate between team and group with examples

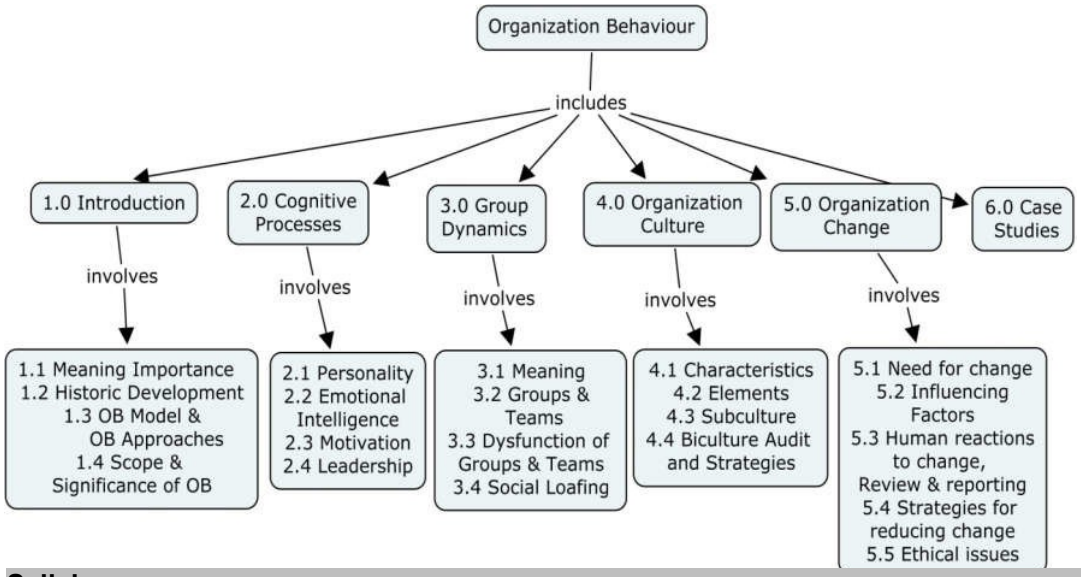
Course Outcome 5(CO5):

1. Identify changes in work place in recent years
2. List the five anchors on which organizational behavior is based
3. Compare and contrast Maslow's needs hierarchy theory with Alderfer's ERG theory

Course Outcome 6(CO6):

1. "Organizations are more likely to succeed when they have an adaptive culture". Give your comments on the statement with reasons
2. Explain why values have gained importance in organizations.
3. Discuss about the stress free balancing work life of the employee of an IT organization.

Concept Map



Syllabus

Introduction: Definition, need and importance of organizational behaviour –Nature and scope –Frame work —Organizational behaviour models. **Individual behaviour:** Personality : types – Factors influencing personality, theories–Types of learners –The learning process –Learning theories –Organizational behaviour modification –Misbehaviour: Types and Management Intervention - Emotions: Emotional Labour –Emotional Intelligence –Theories — Attitudes: Characteristics, Components, Formation, Measurement and Values - Perceptions : Importance , Factors influencing perception –Interpersonal perception -Impression Management Motivation –importance –Types –Effects on work behaviour. **Group behaviour:** Organization structure –Formation –Groups in organizations –Influence –Group dynamics — Emergence of informal leaders and working norms –Group decision making techniques – Team building -Interpersonal relations –Communication –Control. **Leadership and power**: Meaning –Importance–Leadership styles –Theories –Leaders Vs Managers –Sources of power – Power centers –Power and Politics. **Dynamics of organizational behaviour:** Organizational culture and climate –Factors affecting organizational climate –Importance of Job satisfaction –Determinants–Measurements – Influence on behavior - Organizational change – Importance –Stability Vs Change — Proactive Vs Reaction change– The change process — Resistance to change — Managing change - Stress - Work Stressors– Prevention and Management of stress – Balancing work and Life - Organizational development –Characteristicsand objectives –.Organizational effectiveness.

References

1. Stephen P. Robins, “Organisational Behavior”, PHI Learning / Pearson Education, 15thedition,2012.
2. FredLuthans, “Organisational Behavior”, McGraw Hill, 12th Edition, 2005.
3. Schermerhorn, Hunt and Osborn, “Organisational Behavior”, John Wiley, 12th Edition,2011.
4. UdaiPareek, “Understanding Organisational Behaviour”, 2nd Edition, Oxford HigherEducation, 2008.
5. Mc Shane & Von Glinov, “Organisational Behaviour”, 6th Edition, Tata McGraw Hill, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of	COs
1.0	**Introduction to Organization Behaviour**		
1.1	Definition, Meaning and Importance of OB	1	CO1
1.2	Historic developments of OB, Hawthorne experiment		CO1
1.3	Basic OB Model, Different approaches to OB	1	CO1
1.4	Contributing disciplines to OB, Scope of OB, Significance of		CO1
2.0	**Cognitive Processes of Organization Behaviour**		
2.1	**Personality**		
2.1.1	Definition, Origin of the word Personality, Determinants of Personality	1	CO2
2.1.2	Theories of Personality - Psychoanalytic theory, Self theory	1	CO2
2.1.3	Theories of Personality - Holland's personality theory & Myers Briggs Type Indicators)	1	CO2
2.1.4	Theories of Personality - Big 5 personality theory	1	CO2
2.1.5	Attributes of personality		CO2
2.2	**Emotional Intelligence**		
2.2.1	Definition and Meaning, Categories of intelligence	1	CO3
2.2.2	EI Dimensions, Physiology of EI	1	CO3
2.2.3	OB applications of emotions		CO3
2.3	**Motivation**		
2.3.1	Definition, Meaning, Characteristics of Motivation	1	CO4
2.3.2	Process of Motivation		CO4
2.3.3	Theories of Motivation - Maslow's need theory, ERG theory	1	CO4
2.3.4	Theories of Motivation - Hertzberg theory, Expectancy theory	1	CO4
2.3.5	Theories of Motivation - Theory X & Y, McClelland's theory of		CO4
2.3.6	Theories of Motivation - Goal setting theory, Equity theory	1	CO4
2.3.7	Incentives for Motivation		CO4
2.4	**Leadership**		
2.4.1	Definition and Meaning, Styles of leadership	1	CO5
2.4.2	Theories of leadership -Trait theory, Ohio state theory	2	CO5
2.4.3	Theories of leadership - Managerial grid, Contingency theory	1	CO5
2.4.4	Theories of leadership - Path goal theory, Leader Member Exchange(LMX)	2	CO5
2.4.5	Theories of leadership - Transactional & transformational leadership theory	1	CO6
2.4.6	Theories of leadership - Charismatic and Visionary leadership theory. Conflicts and resolution	1	CO6

Course Designers

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22CMPM0 **LEAN CONSTRUCTION**

Category	L	T	P	Credit
PE	2	1	0	3

Preamble

Lean Construction is an essential shift from conventional construction management. Lean approach seeks to improve project delivery by minimizing waste and maximizing value to the customer. This course has been intended to impart the key concepts, tools, and practices to improve the construction processes.

Prerequisite

Building materials and technology

Course Outcomes

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

COs	Course Outcome Statement	Blooms level
CO1	Compare the concepts of Lean Production and Lean construction systems	Understand
CO2	Classify wastes in construction and apply lean techniques for waste reduction	Apply
CO3	Apply Integrated Project Delivery principles in construction projects	Apply
CO4	Apply Collaborative planning techniques in construction projects	Apply
CO5	Analyse various lean tools for planning, measuring the performances and ensuring continuous improvement in construction projects	Analyze
CO6	Summarize the importance of workplace organization, need for implementing Lean and training the employees	Apply

Mapping with Programme Outcomes

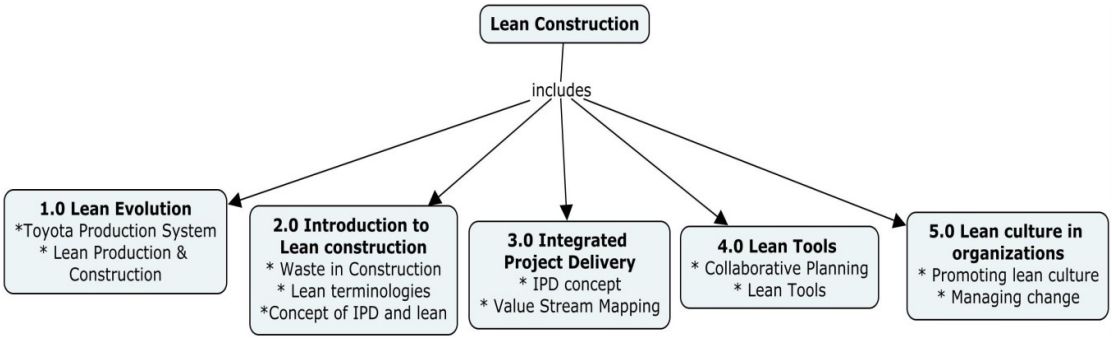
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	S	---	---	L	---	M	L	M	---	---	---	M	L
CO2	S	L	---	L	---	M	M	M	---	S	M	S	M
CO3	S	M	M	L	---	M	M	M	---	S	M	S	S
CO4	S	M	M	M	---	M	S	M	---	S	M	S	M
CO5.	S	M	M	L	---	M	L	M	L	---	---	M	M
CO6	S	L	M	L	---	M	M	M	---	S	M	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Concept Map



Sample Questions for Course Outcome Assessment

Course Outcome 1 (CO1):

1. Highlight the transformation of lean from production to construction systems.
2. List the principles in Toyota Production system and discuss any three of its types
3. Explain the framework of Lean Thinking.

Course Outcome 2 (CO2):

1. Recall the term Lean Construction
2. Taking an example of your choice, write meaningful value proposition
3. Categorize the construction waste as per Lean Concept.

Course Outcome 3 (CO3):

1. Highlight the need and benefits of Integrated Project Delivery
2. As a Lean Expert, apply the concept of Value stream mapping for a Construction Project enumerating its salient features with merits.
3. Compare and contrast the Integrated Project Delivery over conventional project delivery by taking Multi storied Construction Project

Course Outcome 4 (CO4):

1. For a Smart City Development Project, Apply Collaborative planning and Master Planning for effective execution of the activities.
2. As a Project Manager, you are assigned with a responsibility of minimizing waste in construction site. What are all appropriate lean techniques you will adopt to meet the objectives and Justify with reason?
3. Identify the predetermined root causes for missed commitments by taking a construction project of your own. As a Lean expert, summarize the strategies you will to enhance PPC and ensure its sustainability.

Course Outcome 5 (CO5):

1. Discuss the elements of lean culture with benefits
2. Identify and enumerate the strategies to inculcate lean culture in organization
3. Bring out the features of integrating lean in managing changes in organization

Syllabus

Lean – Evolution: Introduction – Lean Production - background, and lean thinking. Toyota Production System. Lean production philosophy. Introduction to Lean Construction. Difference between Lean Production and Lean Construction. **Introduction to Lean construction:** Lean Construction – Overview and Definition, Value Proposition, Waste in Construction,

Terminologies in Lean Construction. **Concept of IPD and lean:** Concepts of Integrated Project Delivery, Value stream mapping for construction processes, Minimizing waste - value-added vs. non-value added activities, Integrated Project Delivery, Case study and mini project discussions **Lean Tools:** Collaborative Planning – Master Planning, Make Ready Schedule, Production Planning Tools for Collaborative Planning – Workflow, Visual Management, 5S, Just-In- Time, Cycle time analysis, Measuring Performances – Plan Percent Complete (PPC), Constraint Analysis and solution through A3 sheets, Continuous improvement, Case study and Mini Project discussions **Lean culture in organization:** Building Lean Culture in an Organization, Human resources and managing change in organization Team building and training.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcome
1.	**Lean – Evolution**		
1.1	Introduction – Lean Production - background and lean thinking.	2	**CO1**
1.2	Toyota Production System. Lean production philosophy.	1	
1.3	Introduction to Lean Construction. Difference between Lean Production and Lean Construction.	2	
2.	**Introduction to Lean construction**		
2.1	Lean Construction – Overview and Definition, Value Proposition,	3	**CO2**
2.2	Waste in Construction, Terminologies in Lean Construction.	2	
3.0	**Concept of IPD and lean**		
3.1	Concepts of Integrated Project Delivery	3	**CO3**
3.2	Value stream mapping for construction processes	2	
3.3	Minimizing waste - value-added vs. non-value added activities	2	
3.4	Integrated Project Delivery, Case study and mini project discussions	3	
4.	**Lean Tools**		
4.1	Collaborative Planning – Master Planning, Make Ready Schedule	3	**CO4**
4.2	Production Planning Tools for Collaborative Planning – Workflow, Visual Management, 5S, Just-In- Time, Cycle time analysis	3	
4.3	Measuring Performances – Plan Percent Complete (PPC)	2	
4.4	Constraint Analysis and solution through A3 sheets, Continuous improvement	2	
4.5	Case study and Mini Project discussions	2	
5.	**Lean culture in organization**		
5.1	Building Lean Culture in an Organization,	2	**CO5**
5.2	Human resources and managing change in organization, Team building and training	2	
	Total Periods	**36**	

Learning Resources

TEXT BOOKS:

1. The Toyota Way Field book, Jeffrey Liker and David Meier, McGraw-Hill, 2006. Lean Production Simplified, Pascal Dennis, Productivity Press, 2007.
2. Womack, James P., and Daniel T. Jones. Lean Thinking. New York, NY: Simon and Schuster, 2003. ISBN: 0743249275.
3. Murman, Earll. Lean Enterprise Value. New York, NY: Palgrave Macmillan, ISBN:0333976975.
4. Forbes and Ahmed (2011), "Modern Construction – Lean Project Delivery and Integrated Practices", CRC Press, Taylor & Francis Group, New York.
5. Patricia Tzortzopoulos, Mike Kagioglou and Lauri Koskela (2020), "Lean Construction – Core Concepts and New Frontiers", Routledge, Taylor & Francis Group, London and New York.
6. Liker and Meier (2006), "The Toyota Way", McGraw-Hill.
7. Supplementary modules (workbook and reading materials) on each topic will shared along with a weekly release of course contents

REFERENCES:

1. Readings athttp://www.leanconstruction.org/readings.htm
2. Hopp,W.J.,andSpearman,M.L.(2011).FactoryPhysics,ThirdEdition, Wavel and Press,LongGrove,Il. 720pp.

Course Designers:

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		Category	L	T	P	Credit
2CMPN0	**AUTOMATION IN CONSTRUCTION**	PE	3	0	0	3

Preamble

To get knowledge about application of automation and use of robots in construction

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statement	Blooms level
CO1	Describe the concepts of building automation	Understand
CO2	Explain the basic concept of Sensors and inspection	Understand
CO3	Apply building management system and automation in on- site projects	Apply
CO4	Apply building management system and automation in off-site projects	Apply
CO5	Select the Application of Robotics in Construction	Apply
CO6	Illustrate the working mechanism of construction robots through case studies	Apply

Assessment Pattern

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

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	-
CO6	M	L	M	M	M	L	S	S	S	M	M	M	S

S- Strong; M-Medium; L-Low

Course Outcome 1 (CO1)

1. Explain the Concept and application of Building Management System
2. Draw the architecture and components of BMS
3. List the requirements and design considerations of building automation system

Course Outcome 2 (CO2):

1. Show the working principles of sensor and actuators associated with automated robots.
2. Explain the data acquisition system of automated robots?
3. Explain the roles of robots in non-destructive evaluation

Course Outcome 3 (CO3):

1. How the computer applications can be implemented in on-site building automation?
2. Take a case study on concrete placing robots in construction site
3. Explain the role of robots in concrete batching plant

Course Outcome 4 (CO4):

1. How the computer applications can be implemented in off-site building automation?
2. Explain the role of robots in material processing
3. Compare and contrast the existing equipment with automated robot in concrete finishing

Course Outcome 5 (CO5):

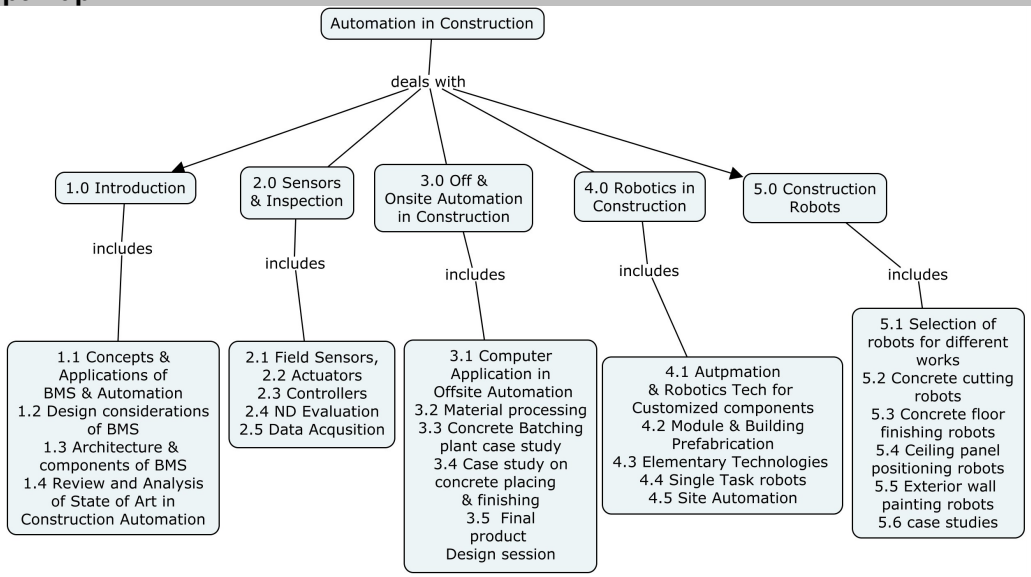
1. List the factors affecting the selection of robots in construction projects
2. Show the working mechanism of single – Task construction robots with neat sketches
3. When will you adopt module and building prefabrication?

Course Outcome 6 (CO6):

1. Explain the working mechanism of Ceiling panel positioning robot
2. Discuss operation and safety precautions of the Exterior wall painting robot

As a safety engineer how would you ensure the safety and training of robotics in construction projects

Concept Map



Syllabus

Introduction Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS- Review and analysis of state- of –art in construction automation. **Sensors and inspection** Field sensors actuators, controllers, non-destructive evaluation, data acquisition, examples of sensors in existing automated equipment. **Off and on-site automation in construction** Off- site automation in construction Information processing (computer applications), materials processing, case study (concrete batch plant) - Existing and prototype equipment for construction – case study (concrete placement and finishing), final product design session. **Robotics in Construction** Automation and robotic technologies for customized component, module and building prefabrication- Elementary technologies and single – Task construction robots - Site automation- robotic on-site factories. **Construction Robots** Selecting robot- Activated concrete cutting robot, concrete floor finishing robot- Ceiling panel positioning robot- Exterior wall painting robot-safety and training- case studies.

Reference Books

1. Javad Majrouhi Sardroud, (2011),"Automated Management of Construction Projects" LAP Lambert Academic Publishing.
2. Majrouhi Sardroud Javad, (2014), "Automation in Construction Management" Scholars' Press.
3. HongleiXu and Xiangyu Wang, (2014), "Optimization and Control Methods in Industrial Engineering and Construction (Intelligent Systems, Control and Automation: Science and Engineering)" Springer.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Concept and application of Building Management System (BMS) and Automation,	1
1.2	Requirements and design considerations and its effect on functional efficiency of building automation system	2
1.3	Architecture and components of BMS	1
1.4	Review and analysis of state- of –art in construction automation	2
2.0	**Sensors and inspection**	
2.1	Field sensors actuators, controllers	1
2.2	Non-destructive evaluation	2
2.3	Data acquisition	1
2.4	Examples of sensors in existing automated equipment	2
3.0	**Off and on-site automation in construction**	
3.1	Off- site automation in construction Information processing (computer applications)	1
3.2	case study (concrete batch plant	2
3.3	- Existing and prototype equipment for construction	1
3.4	Materials processing	1
3.5	case study (concrete placement and finishing), final product design session	1
4.0	**Robotics in Construction**	
4.1	Automation and robotic technologies for customized component	1
4.2	Module and building prefabrication	1
4.3	Elementary technologies	1
4.4	Single Task construction robots	2
4.5	Site automation- robotic on-site factories	1
5.0	**Construction Robots**	
5.1	Selection of robots	1
5.2	Activated concrete cutting robot	1
5.3	Concrete floor finishing robot	1
5.4	Ceiling panel positioning robot	1
5.5	Exterior wall painting robot	1
5.6	safety and training- case studies	1
	Total hours	**36**

Course Designer

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22CMPP0	COMPUTER APPLICATIONS IN CONSTRUCTION ENGINEERING AND PLANNING	Category	L	T	P	Credit
		PE	2	1	0	3

Preamble

To study and understand the optimization techniques, inventory models and scheduling techniques applied to construction engineering.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome	Bloom's Level
CO1	Use of software in construction Industry applications	Apply
CO2	Apply various optimization techniques for specific applications	Apply
CO3	Apply Deterministic and Probabilistic Inventory Models for various applications	Apply
CO4	Analyze the scheduling concepts in projects	Apply
CO5	Solve problems using simulation and ERP systems	Apply
CO6	Forecast delay and risk involved in scheduling of projects	Apply

Mapping with Programme Outcomes

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

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1(CO1):

1.Describe the features of computer aided cost estimation software's in construction engineering

2.Explain the latest software application available to support the construction project
3.List out some IT applications in Construction Industry

Course Outcome 2(CO2):
1.Describe how linear programming can be applied for scheduling projects?
2.write a short note on branch technique
3.mention some limitation of linear programming applied for construction activities

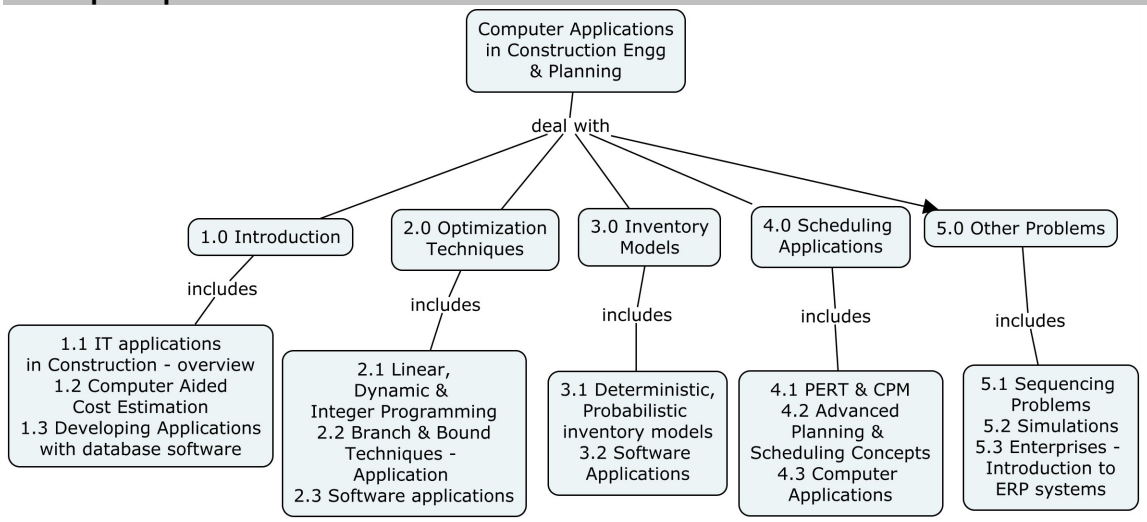
Course Outcome 3(CO3):
1.Describe the deterministic inventory model in detail
2.explain the factors that are important in making decisions related to inventories
3.List out the various probabilistic inventory models

Course Outcome 4(CO4):
1.What is meant by demand rate?
2.Define Shortage Cost
3.Prepare a case study on computer-based scheduling techniques

Course Outcome 5(CO5):
1.Discuss the limitation of CPM based scheduling of construction of construction activities
2.Explain the issues related to the master data management with respect to enterprises
3.what are the service provided by enterprise software?

Course Outcome 6(CO6):
1.Describe the enterprise resource planning in detail
2.Explain the resequencing process for accelerating the schedules
3.How could you forecast the risk associated with construction projects using advanced software's ?

Concept Map



Syllabus

Introduction - Overview of IT Applications in Construction – Construction process – Computerization in Construction – Computer aided Cost Estimation – Developing application with database software. **Optimization Techniques** - Linear, Dynamic and Integer Programming - Branch and Bound Techniques – Application to Production Scheduling, Equipment Replacement, Material Transportation and Work Assignment Problems – Software applications. **Inventory Models** - Deterministic and Probabilistic Inventory Models - Software applications. **Scheduling Application** - PERT and CPM - Advanced planning and scheduling concepts – Computer

applications – Case study. **Other Problems** - Sequencing problems – Simulation – Enterprises – Introduction to ERP systems

References

1. Billy E. Gillet., Introduction to Operations Research – A Computer Oriented Algorithmic Approach, McGraw Hill, 2008.
2. Feigenbaum, L., Construction Scheduling with Primavera Project Planner Prentice Hall Inc., 2002.
3. Ming Sun and Rob Howard, "Understanding I.T. in Construction, Spon Press, Taylor and Francis Group, 2004.
4. Paulson, B.R., Computer Applications in Construction, McGraw Hill, 1995.
5. Tarek Hegazy, Computer-Based Construction Project Management, Pearson New International Edition, 2013.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Overview of IT Applications in Construction	1
1.2	Construction process	1
1.3	Computerization in Construction	1
1.4	Computer aided Cost Estimation	1
1.5	Developing application with database software	
2.0	**Optimization Techniques**	2
2.1	Linear, Dynamic and Integer Programming	1
2.2	Branch and Bound Techniques	2
2.3	Application to Production Scheduling	1
2.4	Equipment Replacement	2
2.5	Material Transportation and Work Assignment Problems	
2.6	Software applications	
3.0	**Inventory Models**	
3.1	Deterministic Inventory Models	2
3.2	Probabilistic Inventory Models	2
3.3	Software applications.	2
4.0	**Scheduling Application**	
4.1	PERT and CPM	2
4.2	Advanced planning and scheduling concepts	2
4.3	Computer applications	1
4.4	Case study	1
5.0	**Other Problems**	
5.1	Sequencing problems	1
5.2	Simulation	2
5.3	Enterprises	2
5.4	Introduction to ERP systems	1
	Total hours	**36**

Course Designers:

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22CMPQ0	SUPPLY CHAIN MANAGEMENT AND LOGISTICS IN CONSTRUCTION	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To gain knowledge about construction supply chain management and to understand the concepts of strategic perspectives, integrated data management, construction logistics and sustainability and logistics operations.

Course Outcomes

On the successful completion of the course, students will:

Cos	Course Outcome Statements	Blooms Levels
CO1	Describe the conceptual and theoretical backgrounds of Supply Chain Management and logistics	Understand
CO2	Identify challenges in construction logistics, JIT concept in construction sites	Understand
CO3	Apply the strategy in logistics function ranging from planning to execution and control	Apply
CO4	Identify the Impact of BIM and new data management capabilities on supply chain management in construction	Apply
CO5	Analyse the implications of various strategic choices and decide a better course of action	Apply
CO6	Understand the role of construction logistic Managers and Delivery management systems	Apply

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	-
CO6	M	L	M	M	M	L	S	S	S	M	M	M	S

S-Strong; M-Medium; L-Low

Assessment Pattern

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

Questions :

CO1:

1.Write the menaing and purpose of supply chian management in construction Industry

2.Develope a frame work for good logistics for ware house in construction proect site in costal region of chennai
3.Dicuss the factors to be considered for effective supply chain management of multi storey building construction project
4.Identify the major drivers for supply chain performance
5.Dicuss the goal of supply chain and explain the impact of supply chain decisions on success of the firm

CO2:

1.Describe the impact ofrisk sharing of supplier perfrmance and information distortion.
2.Discuss the benefits of JIT in inventory control in construction project site.
3.Identify the challenges that associated with construction logistics.

CO3:

1.Explain how to manage supply chain cycle inventory.
2.As a Supply Chain Manager what strategy would you consider for strengthening the supply chain.Justify your answer with suitable reasons
3. List the various logistics methods regarding supply of bulk materials

CO4:

1. Discuss the impact of BIM in SCM
2. Enumerate the benefits of new data management capabilities in a apartment construction projects
3. Correlate data management in integrated SC concept

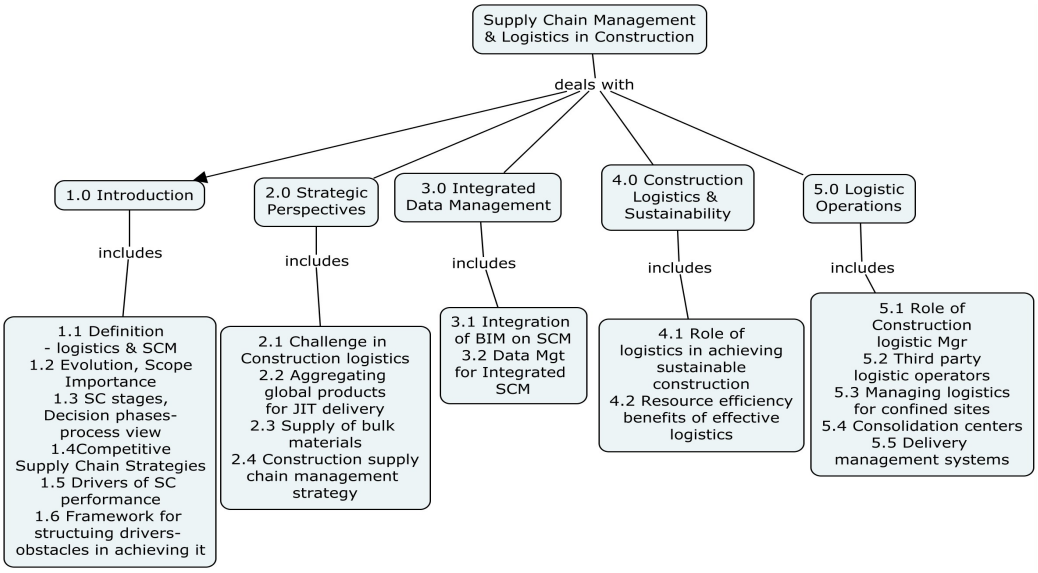
CO5:

1. Recall the role of logistics in achieving sustainable construction
2. Discuss the process you would adopt to increase resource efficiency in construction taking a construction of your choice
3. Define sustainability and need for using integrated SCM for better benefits

CO6:

1. Mention the role of Construction logistics manager
2. Assume you are a logistic manager for a project of confined sites in urban areas, discuss the logistic strategies and operations you would exercise for its efficient execution
3. Describe the various delivery management systems in construction projects

Concept Map



Syllabus

Introduction: Definition of Logistics and SCM: Evolution, Scope, Importance - Supply chain stages and decision phases process view of a supply chain - Supply chain flows- Examples of supply chains- Competitive and supply chain strategies- Achieving strategic fit- Expanding strategic scope- Drivers of supply chain performance- Framework for structuring drivers - Obstacles to achieving fit. **Strategic Perspectives:** Challenge of construction logistics- Aggregating global products for just-in-time delivery to construction sites – Construction Logistics – Supply of bulk materials – Effective management of a construction project supply chain – Construction supply chain management strategy. **Integrated Data Management:** Impact of BIM and new data management capabilities on supply chain management in construction – Data management for integrated supply chains in construction. **Construction Logistics and Sustainability:** Role of logistics in achieving sustainable construction – Resource efficiency benefits of effective logistics **Logistic Operations:** Role of the construction logistics manager – Third party logistics operators in construction – Managing construction logistics for confined sites in urban areas - Consolidation centers in construction logistics – Delivery management systems.

REFERENCES:

1. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.
2. Supply Chain Management, Strategy, Planning, and operation – Sunil Chopra , Peter Meindl and Kalra, Pearson Education, 2011
3. A. Ravi Ravindran, Donald P. Warsing, Supply Chain Engineering: Models and Applications, CRC Press, 2012.
4. G Srinivasan, Quantitative Models in Operations and Supply Chain Management, PHI Learning (P) Ltd, New Delhi, 2010
5. David J.Bloomberg, Stephen Lemay and Joe B.Hanna, Logistics, PHI 2010

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Definition of Logistics and SCM:	1
1.2	Evolution, Scope, Importance - Supply chain stages and decision phases process view of a supply chain -.	1
1.3	Supply chain flows- Examples of supply chains-	1
1.4	Competitive and supply chain strategies- Achieving strategic fit-	1
1.5	Expanding strategic scope- Drivers of supply chain performance- Framework for structuring drivers -Obstacles to achieving fit	1
1.6	Expanding strategic scope- Drivers of supply chain performance- Framework for structuring drivers -Obstacles to achieving fit	1
2.0	**Strategic Perspectives**	
2.1	Challenge of construction logistics	1
2.2	Aggregating global products for just-in-time delivery to construction sites	2
2.3	Construction Logistics – Supply of bulk materials	1
2.4	Effective management of a construction project supply chain	2
2.5	Construction supply chain management strategy	
3.0	**Integrated Data Management**	
3.1	Impact of BIM and new data management capabilities on supply chain management in construction	3
3.2	Data management for integrated supply chains in construction.	3
4.0	**Construction Logistics and Sustainability**	
4.1	Role of logistics in achieving sustainable construction	3

4.2	Resource efficiency benefits of effective logistics	3
5.0	**Logistic Operations**	
5.1	Role of the construction logistics manager	1
5.2	Third party logistics operators in construction	1
5.3	Managing construction logistics for confined sites in urban areas -	2
5.4	Consolidation centres in construction logistics	1
5.5	Delivery management systems	1
	Total hours	**36**

Course Designers:

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2. Mr. P. Selvaprasanth pspciv@tce.edu

22CMPR0	PROJECT SAFETY MANAGEMENT	Category	L	T	P	Credit
		PE	2	1	0	3

Preamble

To study and understand the various safety concepts and requirements applied to construction projects.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statement	Blooms level
CO1	Enumerate the causes and effects of accidents in projects	Understand
CO2	Plan site layout using OSHA standards	Apply
CO3	Apply safety principles for job-site safety assessments	Apply
CO4	Apply the knowledge of contractual obligations relating to safety in projects	Apply
CO5	Develop regulatory procedures for safety in construction projects	Apply
CO6	Frame roles and responsibilities of stakeholders relating to safety in infrastructure projects	Apply

Mapping with Programme Outcomes

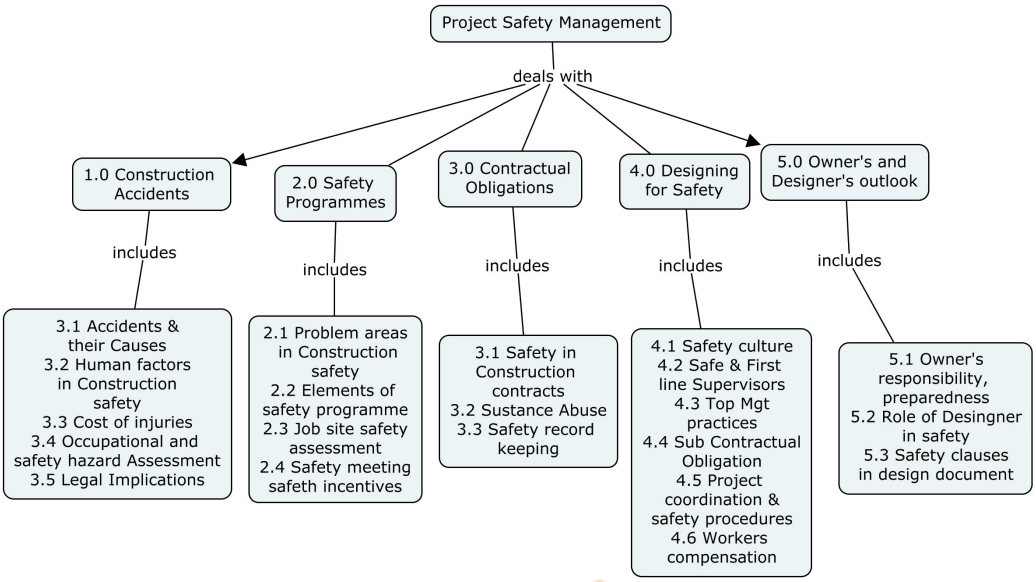
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	M	M	L	M	---	---	---	M	M	M	L	M	S
CO2	S	M	M	L	---	L	M	M	M	M	L	M	M
CO3.	S	S	S	M	---	M	M	S	M	S	M	M	M
CO4.	S	M	M	L	---	L	M	S	M	M	M	S	S
CO5.	S	S	S	L	---	M	L	S	M	S	L	S	S
CO6	S	M	M	S	L	M	M	M	M	S	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Concept Map



Course Level Assessment Questions

Course Outcome 1(CO1):

1. Identify the framework of a Information System
2. Define MIS. Give an example
3. Develop a MIS for a construction project indicating the different types of information subsystems depending on functional areas.

Course Outcome 2(CO2):

1. What are structured Programs?
2. Describe the evolution of various computer based information systems.
3. Demonstrate the stages involved in traditional system life cycle development.

Course Outcome 3(CO3):

1. List the elements of effective safety programmes
2. Compare Integrated Construction Management Information System and Project Management Information System
3. Illustrate the types of knowledge representation in an Executive information system and expert system

Course Outcome 4(CO4):

1. Classify the errors encountered during data entry and how can they be resolved
2. Explain the methods of testing the security of the information systems.
3. Why Cost Benefit Analysis is carried out?

Course Outcome 5(CO5):

1. Mention the Software Engineering qualities
2. Discuss Software specification and Software Metrics
3. Make an overview of Software quality assurance in projects.

Course Outcome 6(CO6):

1. Write any two objectives of Systems Methodology
2. Highlight Software life cycle models and their salient features
3. Explain the Verification and Validation of systems and its software life cycle models.

Syllabus

Construction Accidents - Accidents and their Causes – Human Factors in Construction Safety – Costs of Construction Injuries – Occupational and Safety Hazard Assessment – Legal Implications. **Safety Programmes** - Problem Areas in Construction Safety – Elements of an Effective Safety Programme – Job-Site Safety Assessment – Safety Meetings – Safety Incentives. **Contractual Obligations -** Safety in Construction Contracts – Substance Abuse – Safety Record Keeping. **Designing For Safety -** Safety Culture – Safe Workers – Safety and First Line Supervisors – Safety and Middle Managers – Top Management Practices, Company Activities and Safety – Safety Personnel – Sub contractual Obligation – Project Coordination and Safety Procedures – Workers Compensation. **Owners' And Designers' Outlook -** Owner's responsibility for safely – Owner preparedness – Role of designer in ensuring safety – Safety clause in design document.

References

1. Patrick X.W. Zou ,Riza YosiaSunindijo, Strategic Safety Management in Construction and Engineering John Wiley & Sons, Ltd 2015
2. Jimmy W. Hinze, Construction Safety, Prentice Hall Inc., 1997.
3. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, Construction Safety and Health Management, Prentice Hall Inc., 2001.
4. Tamilnadu Factory Act, Department of Inspectorate of factories, Tamilnadu. Health Management, Prentice Hall Inc., 2001.
5. Bhattacharjee S.K. Safety Management in Construction (Principles and Practice), Khanna Publishers, New Delhi 2011

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Construction Accidents**	
1.1	Accidents and their Causes	1
1.2	Human Factors in Construction Safety	1
1.3	Costs of Construction Injuries	1
1.4	Occupational and Safety Hazard Assessment	2
1.5	Legal Implications	1
2.0	**Safety Programmes**	
2.1	Problem Areas in Construction Safety	1
2.2	Elements of an Effective Safety Programme	1
2.3	Job-Site Safety Assessment	1
2.4	Safety Meetings	2
2.5	Safety Incentives	1
3.0	**Contractual Obligations**	
3.1	Safety in Construction Contracts	2
3.2	Substance Abuse	2
3.3	Safety Record Keeping.	2
4.0	**Designing For Safety**	
4.1	Safety Culture – Safe Workers	2
4.2	Safety and First Line Supervisors – Safety and Middle Managers – Top Management Practices	2
4.3	Company Activities and Safety	1
4.4	Safety Personnel – Sub contractual Obligation	1
4.5	Project Coordination and Safety Procedures	1
4.6	Workers Compensation	1

5.0	**Owners' And Designers' Outlook**	
5.1	Owner's responsibility for safely –.	1
5.2	Owner preparedness	1
5.3	Role of designer in ensuring safety	2
5.4	Safety clause in design document	2
	Total hours	**36**

Course Designers:

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22CMPS0	QUALITY CONTROL AND QUALITY ASSURANCE IN CONSTRUCTION	Category	L	T	P	Credit
		PE	2	1	0	3

Preamble

To study the concepts of quality assurance and control techniques in construction

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	Bloom's Level
CO1	Enumerate the knowledge of quality management guidelines, quality circles.	Understand
CO2	Apply the quality standards for preparing Quality system documents	Apply
CO3	Select appropriate inspection procedures for quality planning of construction operations	Apply
CO4	Choose the techniques and tools for Quality Assurance in Construction Industry projects	Apply
CO5	Select the techniques and tools for Quality Control in Construction projects	Apply
CO6	Apply the quality improvement techniques to given project circumstances	Apply

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
CO6	S	M	M	S	L	M	M	M	M	S	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Outcome Questions

Course Outcome 1

1.Define Quality circle

2.List the factors affecting the quality of construction projects

3. summarise the roles and responsibilities of quality engineer

Course Outcome 2

1.Under what circumstance would you recommend BS Norms?

2.Explain the family of ISO standards

3.How will you complete third party certification in construction quality?

Course Outcome 3

1.List the objectives of Quality planning in construction projects

2.Explain the concepts of Ergonomics

3.As a quality engineer how will you address the costumer satisfaction in turn key projects?

Course Outcome 4

1.Compare and Contrast QA and QC

2.List the inspection procedures of construction projects that you adopt in construction site to improve the quality of construction projects.

3.What are the essential requirement of reliability testing?

Course Outcome 5

1.As a quality engineer how would you improve the quality of construction by selecting new materials?

2.How the drawings that can influence the quality of construction projects?

3.Explain the importance of specification of materials in construction quality

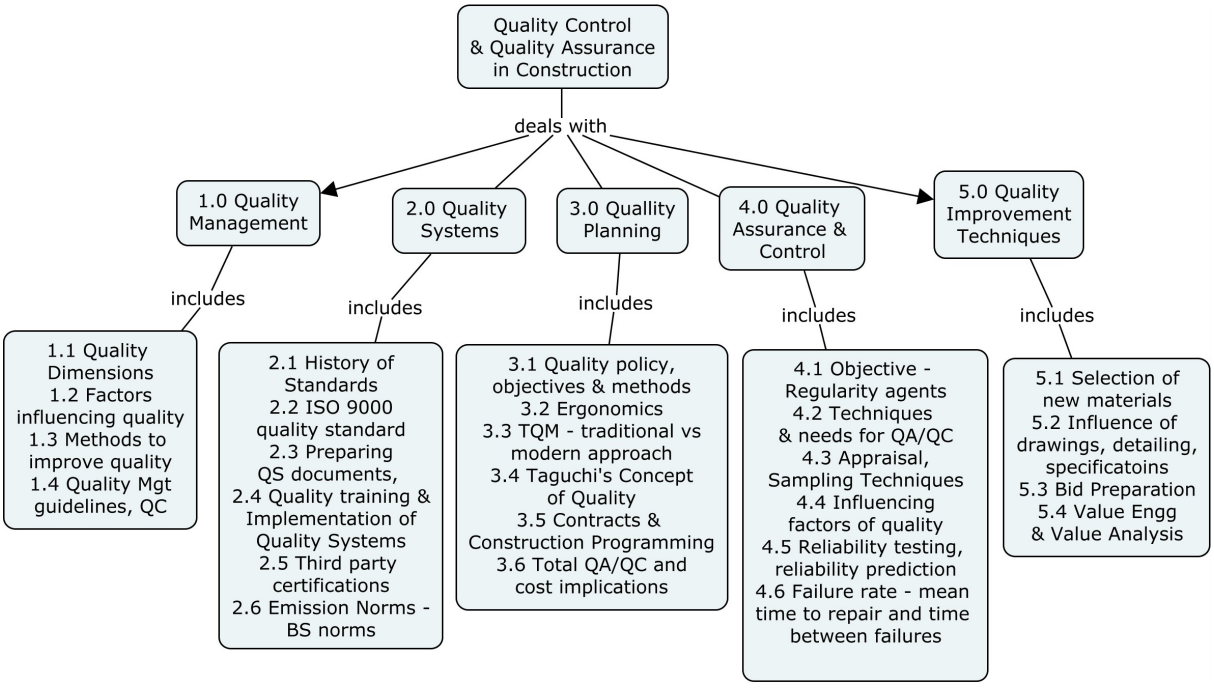
Course Outcome 6

1.Explain the concept of value engineering

2.How the value engineering that would improve the quality of particular projects?

3.List the causes that can influence the speed of construction projects.

Concept Map



Syllabus

Quality Management - Introduction – Definitions and objectives – Dimensions of quality - Factors influencing construction quality – Responsibilities and authority – Methods to improve quality – Quality Process - Quality plan – Quality Management Guidelines – Quality circles. **Quality Systems** - Introduction – History of standards - Quality system standard – ISO 9000 family of standards – Requirements – Preparing Quality System Documents – Quality related training – Implementing a Quality system – Third party Certification – Emission Norms – BS Norms. **Quality Planning** - Quality Policy, Objectives and methods in Construction industry - Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance – TQM – Traditional approach vs. Modern approach – Principles of TQM - Taguchi's concept of quality – Quality function deployment - Codes and Standards – Documents – Contract and construction programming – Inspection procedures - Processes and products – Total QA / QC programme and cost implication. **Quality Assurance And Control** - Objectives – Regularity agent, owner, design, contract and construction oriented objectives, methods – Techniques and needs of QA/QC – Different aspects of quality – Appraisals – Sampling techniques – Sampling plan – Sampling Terms – AQL, LTPD, AOL - Factors influencing construction quality – Critical, major failure aspects and failure mode analysis, – Stability methods and tools, optimum design – Reliability testing, reliability coefficient and reliability prediction – Failure rate – Mean time to failure – Mean time to repair – Mean time between failures. **Quality Improvement Techniques** - Selection of new materials – Influence of drawings, detailing, specification, standardization – Bid preparation – Construction activity, environmental safety, social and environmental factors – Natural causes and speed of construction – Life cycle costing – Value engineering and value analysis

References

1. Hutchins.G, ISO 9000: A Comprehensive Guide to Registration, Audit Guidelines and Successful Certification, Viva Books Pvt. Ltd., 1994.
2. James, J.O' Brian, Construction Inspection Handbook – Total Quality Management, Van Nostrand, 1997
3. John L. Ashford, the Management of Quality in Construction, E &F.N.Spon, 1989.
4. Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, McGraw Hill, 2001
5. Steven McCabe, Quality Improvement Techniques in Construction, Addison Wesley Longman Ltd, 1998.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Quality Management**	
1.1	Introduction – Definitions and objectives	1
1.2	Dimensions of quality	1
1.3	Factors influencing construction quality	1
1.4	Responsibilities and authority – Methods to improve quality	1
1.5	Quality Process - Quality plan	1
1.6	Quality Management Guidelines – Quality circles.	1
2.0	**Quality Systems**	
2.1	Introduction – History of standards	1
2.2	Quality system standard – ISO 9000 family of standards	1
2.3	Requirements – Preparing Quality System Documents	1
2.4	Quality related training	1

2.5	Implementing a Quality system	1
2.6	Third party Certification – Emission Norms – BS Norms	1
3.0	**Quality Planning**	
3.1	Quality Policy, Objectives and methods in Construction industry -	1
3.2	Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance –	1
3.3	TQM – Traditional approach vs. Modern approach – Principles of TQM - Taguchi's concept of quality –	1
3.4	Quality function deployment - Codes and Standards –	1
3.5	Documents – Contract and construction programming –	1
3.6	Inspection procedures - Processes and products –	1
3.7	Total QA / QC programme and cost implication	
4.0	**Quality Assurance and Control**	
4.1	Objectives – Regularity agent, owner, design, contract and construction-oriented objectives, methods –	1
4.2	Techniques and needs of QA/QC – Different aspects of quality – Appraisals –	1
4.3	Sampling techniques – Sampling plan – Sampling Terms – AQL, LTPD, AOL -	1
4.4	Factors influencing construction quality – Critical, major failure aspects and failure mode analysis, –	1
4.5	Stability methods and tools, optimum design –	1
4.6	Reliability testing, reliability coefficient and reliability prediction – Failure rate – Mean time to failure – Mean time to repair – Mean time between failures	1
5.0	**Quality Improvement Techniques**	
5.1	Selection of new materials	1
5.2	Influence of drawings, detailing, specification, standardization	1
5.3	Bid preparation – Construction activity, environmental safety, social and environmental factors	1
5.4	Natural causes and speed of construction	1
5.5	Life cycle costing	1
5.6	Value engineering and value analysis	1
	Total hours	**36**

Course Designers:

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		Category	L	T	P	Credit
22CMPT0	**SHORING, SCAFFOLDING AND FORMWORK**	PE	3	0	0	3

Preamble

To disseminate knowledge about detailed planning, design and erection of formwork for various elements such as slabs, beams, columns, walls, shells and tunnels

Prerequisite

Building Construction technology

Course Outcomes

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

COs	Course Outcome Statement	Blooms Level
CO1	Plan site equipment and plant for formwork	Apply
CO2	Select material accessories for formwork connection and analyse pressures on formworks	Apply
CO3	Design the forms and shores	Apply
CO4	Apply the knowledge of erecting forms for beams, slabs, columns, walls to avoid their failures.	Analyse
CO5	Apply the knowledge of forms and its erection for domes and tunnels	Apply
CO6	Apply the knowledge of types of slip forms and scaffolds	Apply

Mapping with Programme Outcomes

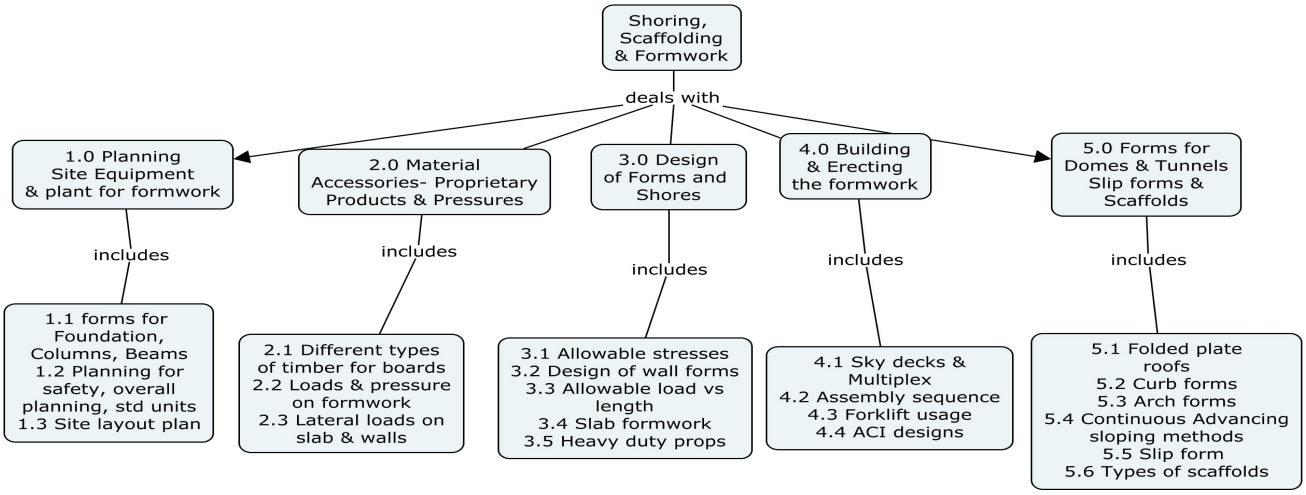
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	L	M	L	---	---	---	---	L	M	---	---	S	M
CO2	M	L	---	L	---	L	---	---	---	---	M	M	L
CO3	M	M	S	S	---	L	M	L	M	S	M	S	L
CO4	M	M	S	S	---	L	M	---	M	S	---	S	M
CO5	S	L	---	---	---	L	M	---	M	S	M	S	M
CO6	S	L	L	M	---	L	---	L	---	S	M	S	L

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Concept Map



Course Level Assessment Questions

Course Outcome 1(CO1):

1. List the objectives of formwork building
2. Write short notes on Standard units, Corner units, Pass units
3. Prepare a methodology for Planning crane arrangements and site layout plan

Course Outcome 2(CO2):

1. Discuss Lumber and its types
2. Summarize Allowable withdrawal load and lateral load
3. Demonstrate the process of handling Vertical loads for design of slab forms

Course Outcome 3(CO3):

1. How will you ensure Lateral stability in forms?
2. Explain Beam forms - Column forms
3. Identify the factors influencing on Stacking Towers - Free standing and restrained and prepare remedial measure for effective execution

Course Outcome 4(CO4):

1. Recall job mill.
2. Discuss the various Forms for Footings
3. Summarize Design deficiencies - Permitted and gradual irregularities and their preventative measures.

Course Outcome 5(CO5):

1. What is Translational shells?
2. Describe Typical barrel vaults Folded plate roof details
3. Correlate the features of Cut and cover construction and their salient features.

Course Outcome 6(CO6):

1. Mention the Slip Forms - Principles
2. Summarize the Safety in slip forms special structures built with slip form Technique
3. Illustate the various types of scaffolds with suitable examples in site.

Syllabus

Planning, Site Equipment & Plant for Form Work Introduction - Forms for foundations, columns, beams walls etc., General objectives of formwork building - Planning for safety - Development of a Basic System - Key Areas of cost reduction -Planning examples. Overall Planning - Detailed planning - Standard units - Corner units – Pass units - Calculation of labour constants - Formwork hours - Labour Requirement – Overall programme - Detailed programme - Costing - Planning crane arrangements - Site layout plan -Transporting plant - Formwork beams - Scaffold frames - Framed panel formwork – Formwork accessories**. Materials Accessories Proprietary Products & Pressures** Lumber - Types - Finish - Sheathing boards working stresses

- Repetitive member stress - Plywood - Types and grades - Jointing Boarding - Textured surfaces and strength – Reconstituted wood - Steel - Aluminum - Hardware and fasteners - Nails in Plywood - Allowable withdrawal load and lateral load. Pressures on formwork - Examples - Vertical loads for design of slab forms - Uplift on shores - Laterals loads on slabs and walls. **Design of Forms and Shores** Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability -Shear, Bearing - Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each. Simple wood stresses - Slenderness ratio - Allowable load vs length behaviour of wood shores - Form lining Design Tables for Wall formwork - Slab Formwork - Column Formwork – Slab props - Stacking Towers - Free standing and restrained - Rosett Shoring - Shoring Tower – Heavy Duty props. **Building and Erecting the Form Work** Carpentry Shop and job mill - Forms for Footings - Wall footings - Column footings - Sloped footing forms - Strap footing - Stepped footing - Slab form systems - Sky deck and Multiflex – Customized slab table - Standard Table module forms - Swivel head and uniportal head - Assembly sequence - Cycling with lifting fork - Moving with table trolley and table prop. Various causes of failures - ACI - Design deficiencies - Permitted and gradual irregularities. **Forms for Domes and Tunnels, Slip Forms and Scaffolds** Hemispherical, Parabolic, Translational shells - Typical barrel vaults Folded plate roof details -Forms for Thin Shell roof slabs design considerations - Building the forms - Placing concrete -Form removed -Strength requirements - Tunnel forming components - Curb forms invert forms -Arch forms - Concrete placement methods - Cut and cover construction - Bulk head method -Pressures on tunnels - Continuous Advancing Slope method - Form construction - Shafts. Slip Forms - Principles -Types - advantages - Functions of various components - Planning -Desirable characteristics of concrete - Common problems faced - Safety in slip forms special structures built with slip form Technique - Types of scaffolds - Putlog and independent scaffold -Single pole scaffolds - Truss suspended - Gantry and system scaffolds.

Reference Books

1. Austin, C.K., Formwork for Concrete, Cleaver -Hume Press Ltd., London, 1996.
2. Hurd, M.K., Formwork for Concrete, Special Publication No.4, American Concrete Institute, Detroit, 1996
3. Michael P. Hurst, Construction Press, London and New York, 2003.
4. Robert L. Peurifoy and Garold D. Oberlender, Formwork for Concrete Structures, McGraw - Hill, 1996.
5. Kumar NeerajJha, Formwork for Concrete Structures, 2017

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Planning, Site Equipment & Plant for Form Work**	
1.1	Introduction - Forms for foundations, columns, beams walls etc.,	1
1.2	General objectives of formwork building - Planning for safety -	1
1.3	Development of a Basic System - Key Areas of cost reduction -Planning examples.	1
1.4	Overall Planning - Detailed planning - Standard units - Corner units – Pass units	1
1.5	Calculation of labour constants - Formwork hours - Labour Requirement	
1.6	Overall programme - Detailed programme - Costing - Planning crane arrangements -	1
1.7	Site layout plan -Transporting plant - Formwork beams - Scaffold frames - Framed panel formwork – Formwork accessories	1
2.0	**Materials Accessories Proprietary Products & Pressures**	
2.1	Lumber - Types - Finish - Sheathing boards working stresses - Repetitive member stress - Plywood - Types and grades	1
2.2	Jointing Boarding - Textured surfaces and strength – Reconstituted	1

	wood - Steel - Aluminum -.	
2.3	Hardware and fasteners - Nails in Plywood - Allowable withdrawal load and lateral load.	1
2.4	Pressures on formwork - Examples - Vertical loads for design of slab forms	1
2.5	Uplift on shores	1
2.6	Laterals loads on slabs and walls	1
3.0	**Design of Forms and Shores**	
3.1	Shores Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability -Shear, Bearing -	1
3.2	Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each.	1
3.3	Simple wood stresses - Slenderness ratio - Allowable load vs length behaviour of wood shores -	1
3.4	Form lining Design Tables for Wall formwork - Slab Formwork -	1
3.5	Column Formwork – Slab props - Stacking Towers -.	1
3.6	Free standing and restrained - Rosett Shoring - Shoring Tower – Heavy Duty props	1
4.0	**Building and Erecting the Form Work**	
4.1	Carpentry Shop and job mill - Forms for Footings - Wall footings - Column footings - Sloped footing forms - Strap footing - Stepped footing	1
4.2	Slab form systems - Sky deck and Multiflex – Customized slab table - Standard Table module forms	1
4.3	Swivel head and uniportal head - Assembly sequence - Cycling with lifting fork	1
4.4	Moving with table trolley and table prop -Various causes of failures	1
4.5	ACI - Design deficiencies	1
4.6	Permitted and gradual irregularities	1
5.0	**Forms for Domes and Tunnels, Slip Forms and Scaffolds**	
5.1	Hemispherical, Parabolic, Translational shells - Typical barrel vaults Folded plate roof details -Forms for Thin Shell roof slabs design considerations	1
5.2	Building the forms - Placing concrete -Form removed -Strength requirements -Tunnel forming components - Curb forms invert forms - Arch forms	1
5.3	Concrete placement methods - Cut and cover construction - Bulk head method -Pressures on tunnels - Continuous Advancing Slope method - Form construction - Shafts.	1
5.4	Slip Forms - Principles -Types - advantages - Functions of various components - Planning -Desirable characteristics of concrete - Common problems faced	1
5.5	Safety in slip forms special structures built with slip form Technique	1
5.6	Types of scaffolds - Putlog and independent scaffold -Single pole scaffolds - Truss suspended - Gantry and system scaffolds	1
	Total hours	**36**

Course Designer

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22CMPU0	ADVANCED CONSTRUCTION TECHNIQUES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To study and understand the latest construction techniques applied to engineering construction for sub structure, super structure, special structures, rehabilitation and strengthening techniques and demolition techniques.

Prerequisite

Building Technology

Course Outcomes

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

COs	Course Outcome Statement	Bloom's Level
CO1	Explain the modern construction techniques used in the sub structure construction	Understand
CO2	Identify and suggest appropriate solutions to problems in deep excavation	Apply
CO3	Demonstrate knowledge and understanding of the principles and concepts relevant to super structure construction of buildings	Apply
CO4	Apply the concepts learnt to construction of special structures	Apply
CO5	Choose appropriate strengthening and repair methods for various distresses in structures	Apply
CO6	Select suitable technique for demolition of structures	Apply

Assessment Pattern: Cognitive Domain

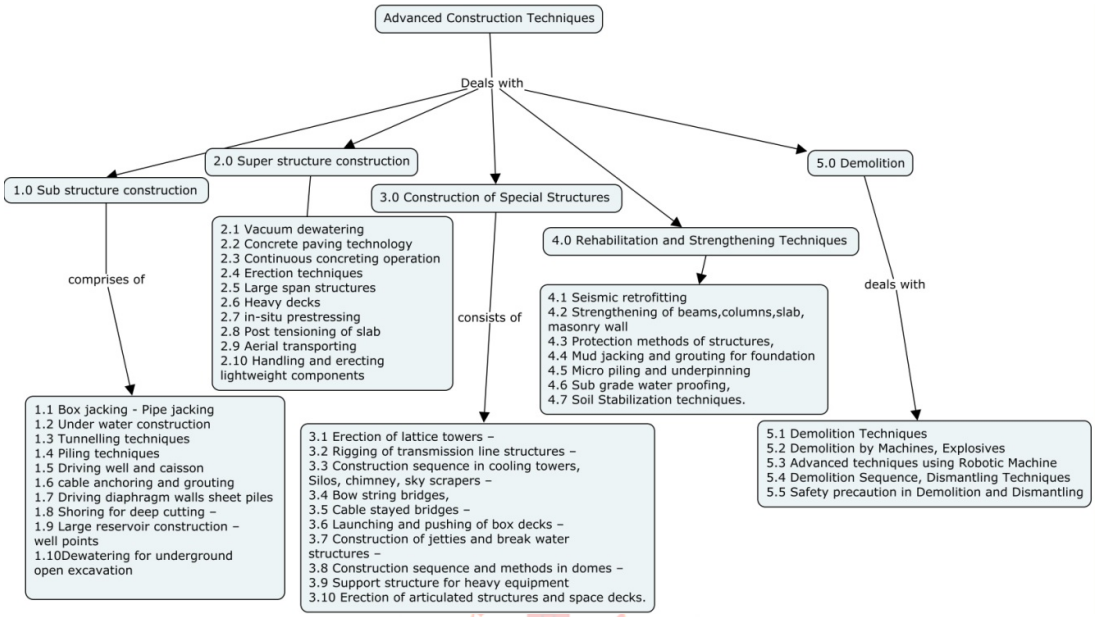
Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	10	20	10
Understand	30	20	20
Apply	60	60	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
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
CO6.	M	M	M	M	L	L	L	---	M	M	M	M	M

S- Strong; M-Medium; L-Low

Concept Map



Course Level Assessment Questions

Course Outcome 1(CO1):

1. Explain the construction method of BoxJacking.
2. Discuss diaphragm walls
3. Illustrate with sketches the different piling techniques.

Course Outcome 2(CO2):

1. Discuss Shoring for deep cutting
2. Summarize dewatering with well points.
3. Make an overview of Dewatering for underground open excavation.

Course Outcome 3(CO3):

1. Discuss the launching techniques for heavy decks with the help of sketches
2. Explain the Erection techniques of tall structures
3. Illustrate the handling and erecting lightweight components on tall structures.

Course Outcome 4(CO4):

1. Differentiate between Bow String bridges and Cable Stayed bridges with sketches.
2. Discuss the construction sequence of Domes.
3. Construction of jetties and break water structures

Course Outcome 5(CO5):

1. Recall Seismic retrofitting
2. Write short notes on Protection methods of structures
3. Correlate the features of Micro piling and underpinning for strengthening floor and shallow profile

Course Outcome 6(CO6):

1. List the various Dismantling Techniques
2. Write short notes on Demolition by Machines, Explosives, Robotic Machines
3. Illustrate Safety precaution in Demolition and Dismantling

Syllabus

Sub structure construction Box jacking - Pipe jacking - Under water construction of diaphragm walls and basement - Tunnelling techniques - Piling techniques - Driving well and caisson - sinking cofferdam – cable anchoring and grouting - Driving diaphragm walls, Sheet piles - Laying operations for built up offshore system - Shoring for deep cutting - Large reservoir construction - well points – Dewatering for underground open excavation. **Super structure 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 – Erection techniques of tall structures, Large span structures – launching techniques for heavy decks – in-situ prestressing in high rise structures, Post tensioning of slab- aerial transporting – Handling and erecting lightweight components on tall structures. **Construction of Special Structures** Erection of lattice towers - 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 – Construction of jetties and break water structures – Construction sequence and methods in domes – Support structure for heavy equipment and machinery in heavy industries – Erection of articulated structures and space decks**. Rehabilitation and Strengthening Techniques** Seismic retrofitting - Strengthening of beams - Strengthening of columns - Strengthening of slab - Strengthening of masonry wall, Protection methods of structures, Mud jacking and grouting for foundation – Micro piling and underpinning for strengthening floor and shallow profile - Sub grade water proofing, Soil Stabilization techniques. **Demolition** Demolition Techniques, Demolition by Machines, Demolition by Explosives, Advanced techniques using Robotic Machines, Demolition Sequence, Dismantling Techniques, Safety precaution in Demolition and Dismantling.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcome
1.	**Sub structure construction**		
1.1	Box jacking - Pipe jacking - Under water construction of diaphragm walls and basement - Tunnelling techniques	2	**CO1**
1.2	Piling techniques - Driving well and caisson - sinking cofferdam – cable anchoring and grouting -	2	
1.3	Driving diaphragm walls, Sheet piles, Laying operations for built up offshore system	1	
1.4	Shoring for deep cutting - Large reservoir construction - well points – Dewatering for underground open excavation.	2	**CO2**
2.	**Super structure construction for buildings**		
2.1	Vacuum dewatering of concrete flooring – Concrete paving technology	1	**CO3**
2.2	Techniques of construction for continuous concreting operation in tall buildings of various shape, sections	2	
2.3	Erection techniques of tall structures, Large span structures – launching techniques for heavy decks	2	
2.4	In-situ prestressing in high rise structures, Post tensioning of slab- aerial transporting	2	
2.5	Handling and erecting lightweight components on tall structures.	2	
3.0	**Construction of Special Structures**		
3.1	Erection of lattice towers - Rigging of transmission line structures - Construction sequence in cooling towers, Silos, chimney, sky scrapers	2	**CO4**
3.2	Bow string bridges, Cable stayed bridges –Launching and pushing of box decks	2	
3.3	Construction of jetties and break water structures – Construction sequence and methods in domes	2	
3.4	Support structure for heavy equipment and machinery– Erection of articulated structures and space decks.	2	

4.	**Rehabilitation and Strengthening Techniques**		
4.1	Seismic retrofitting - Strengthening of beams, columns, slab, masonry wall –-	2	**CO5**
4.2	Protection methods of structures, Mud jacking and grouting for foundation	2	
4.3	Micro piling and underpinning for strengthening floor and shallow profile	2	
4.4	Sub grade water proofing, Soil Stabilization techniques	2	
5.	**Demolition**		
5.1	Demolition Techniques, Demolition by Machines, Explosives, Robotic Machines	2	**CO6**
5.2	Demolition Sequence, Dismantling Techniques, Safety precaution in Demolition and Dismantling	2	
	Total Periods	**36**	

Reference Books

1. Jerry Irvine, Advanced Construction Techniques, CA Rocket, 1984
2. Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons, 1992.
3. Peter H.Emmons, “Concrete repair and maintenance illustrated”, Galgotia Publications Pvt. Ltd., 2001.Press, 2008.
4. Robertwade Brown, Practical foundation engineering hand book, McGraw Hill Publications, 1995.
5. Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University, New Delhi, 2008.

Course Designer

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22CMPV0	MATERIAL PROCUREMENT AND MANAGEMENT	Category	L	T	P	Credit
		PC	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.

Course Outcomes

On the successful completion of the course, students will:

Course Outcomes	Description	Blooms Levels
CO1	Identify the need and role of material management	Understand
CO2	Classify materials, identify sources of procurement, conduct vendor analysis	Apply
CO3	Exercise control for effective management of inventory	Apply
CO4	Manage stores and plan site layout	Apply
CO5	Exercise quality control on materials	Apply
CO6	Apply MMS in planning, procurement, inventory and cost control, evaluate projects and manage risks	Apply

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
CO6	M	S	M	L	-	S	S	M	L	S	M	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write the need and significance of material management
2. Discuss the roles of a material manager
3. Write two objectives of management of materials

Course Outcome 2 (CO2):

1. Write the need for standardization/ codification of materials in construction industry
2. As a material manager of a firm discuss the procedure you would adopt for identification of selection of appropriate vendor for purchase of inventory. Give suitable justification
3. Discuss the principle of Just in time management in relation to inventory

Course Outcome 3 (CO3):

1. Mention the importance of selective inventory control in industry
2. As an inventory manager discuss the techniques you would adopt in your industry tocontrol inventory so as to achieve economy. Give suitable reasons
3. Write a note on indices used for assessment of effectiveness of inventory management

Course Outcome 4 (CO4):

1. Discuss the measures to be taken to maintain stores
2. Write a detailed note on scheduling of men, materials and equipment for projects
3. Write a note on site layout and organization followed in construction

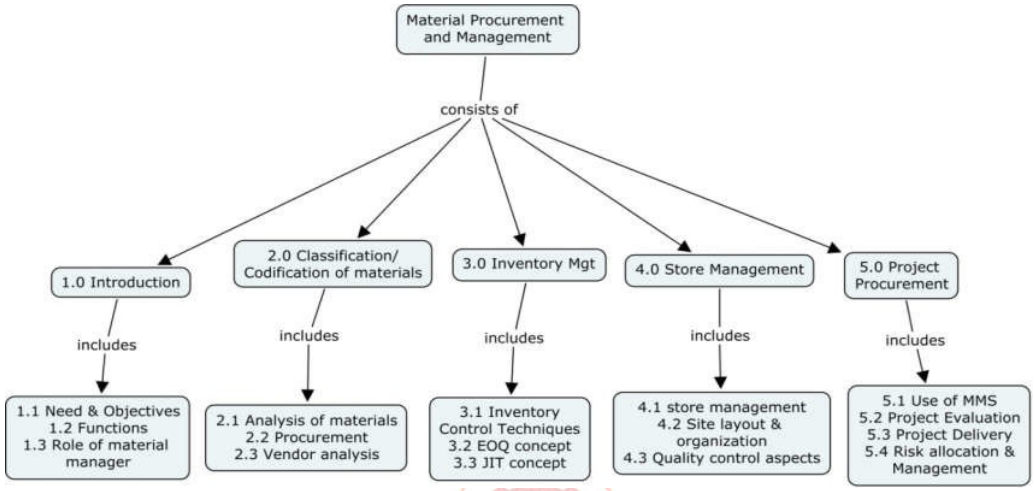
Course Outcome 5 (CO5):

1. Identify and discuss the measures you would adopt to maintain quality in materialmanagement in your industry
2. Discuss the quality control techniques in construction materials
3. Discuss the sampling techniques in quality control process

Course Outcome 6 (CO6):

1. Discuss the merits of using MMS for management of materials in industry
2. As an infrastructure engineer suggest suitable measures of identification and management of risks in relation to material management taking a project of your choice
3. Write a note on project evaluation, its methods discussing its merits and limitations

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. Chitale A.K. and R.C. Gupta, “Material Management – Text and Cases”, Prentice Hall of India Pvt. Ltd., 2007
2. Denise Bower, “Management of Procurement”, Construction Management Series, Thomas Telford Publishing, 2003
3. Jhamb L.C., “Inventory Management”, Everest Publishing house, 2005
4. Peter Holm Andreasen, “Dynamics of Procurement Management – A Complexity Approach”, Copenhagen Business School, 2012
5. Peter Baily, David Farmer, Barry Crocker, David Jessop & David Jones, “Procurement Principles and Management”, FT Prentice Hall, 2010

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	COs
1.0	**Introduction to Material Procurement and Management**		
1.1	Need and Importance of material management and its role in construction industry	1	CO1
1.2	Scope, objectives and functions of material management, Integrated approach to materials management	2	CO1
1.3	Role of materials manager		CO1
2.0	**Classification and Codification of Materials of Construction**		
2.1	ABC, FSN - Procedure and its use	1	CO2
	VED, SOS analysis - Procedure and its use	2	CO2
2.2	Standardization in materials and their management, Procurement, Identification of sources of procurement	2	CO2
2.3	Vendor analysis concept of (MRKP) Material requirement planning, planning, purchase procedure, legal aspects	2	CO2
3.0	**Inventory Management**		
3.1	Inventory Control techniques – principle and applications	2	CO3

3.2	EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control,	2	CO3
	Safety stock, stock outs, application of AC analysis in inventory control	2	CO3
3.3	Concept of Just in time management(JIT), Indices used for assessment of effectiveness of inventory	1	CO3
4.0	**Stores Management**		
4.1	Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing,	2	CO4
4.2	Site layout and site organization, scheduling of men, materials and equipment.	2	CO4
4.3	Quality Control – Conventional methods of quality control of Construction materials. Statistical method	2	CO5
	Sampling techniques quality control in process. Quality management and its economics	2	CO5
5.0	**Project procurement**		
5.1	Project procurement processes: Use of (MMS) – Materials Management Systems in materials	2	CO6
	Procurement, inventory control, cost control	2	CO6
5.2	Project evaluation: Discounted Cash Flow, Real Options Theory. Project delivery methods, Project delivery methods. Competitive bidding	2	CO6
5.3	Project Delivery: Integrated Project Delivery	2	CO6
5.4	Risk Allocation and Management, Contract Negotiation	2	CO6
	Public Private Partnerships	1	CO6
Total Hours		**36**	

Course Designers:

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M.E DEGREE (Construction Engineering and Management) PROGRAMME

- ***22CM271 - Building Information Modelling Lab (Program Core Course)***

For the Students admitted from the academic year 2025-2026 onwards

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institution affiliated to Anna University)

MADURAI – 625 015

Approved in 69th Academic council meeting held on 28.06.2025

22CM271	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 Modelling (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 modelling 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 Modelling (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 intend 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 be able to:

COs	Course Outcomes Statements	Blooms Levels
CO1	Understand concepts of Building Information Modeling (BIM)	Understand
CO2	Review software and technology available for BIM	Apply
CO3	Use BIM software create a model of a building	Apply
CO4	Use BIM to check for interferences and conflicts on a building construction project	Apply
CO5	Explore construction scheduling and sequencing using BIM	Apply
CO6	Explore cost estimating and Tracking using BIM	Apply

List of Experiments

1. Introduction to Building Information Modelling (BIM), Definition, From CAD to BIM.
2. Level of Detail (LOD) in BIM, Necessities of BIM, Benefits of BIM, Software Introduction.
3. Creating Work sets, Workspace, New file, File saving formats
4. Usage of tools: Export and Import options, Reference Attachments, Grid system manager, Floor level manager,
5. Usage of tools: Usage of Architectural tool and Structural Tool to develop a Building
6. Usage of tools: Usage of Mechanical, Electrical and Plumbing Tools in the developed building
7. Quantity Estimation and Duration Calculation
8. Visualization and Rendering, BIM based Construction Cost Estimating and Scheduling.
9. Preparing a 3D model of G+2 storey residential building incorporating the essential features given its plan
10. Preparing a 3D model of a metro station building given its plan
11. Develop 4D model by integrating developed 3D model and Schedule

12. Develop 5D model by incorporating the 4D model with cost calculation and Tracking the same

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

Course Designers:

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M.E DEGREE (Construction Engineering and Management) PROGRAMME

- ***22CMPW0 - Subsurface Exploration and Field Testing (Program Elective)***

For the students admitted from the academic year 2022-2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institution affiliated to Anna University)

MADURAI – 625 015

Approved in the 70th Academic Council Meeting held on 13.12.2025

22CMPW0	SUBSURFACE EXPLORATION AND FIELD TESTING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course offers the methods for assessing the subsurface condition at the construction site during detailed site investigation. Students are exposed to various field and in-situ penetration tests for determining the soil and foundation parameters. Also, knowledge on appropriate ground improvement and soil stabilization techniques are imparted to overcome the challenges posed due to poor ground conditions at the site.

Prerequisite

Knowledge on Soil Mechanics and Foundation Engineering

Course Outcomes

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

COs	Course Outcome Statements	Bloom's Level
CO1	Understand the significance of site investigation and explain the process of boring and sampling techniques	Understand
CO2	Understand the practical significance of the results obtained from geophysical test methods.	Understand
CO3	Recommend and demonstrate suitable field tests for predicting the soil and foundation parameters	Apply
CO4	Recommend and demonstrate appropriate in-situ penetration test based on the soil conditions at the site	Apply
CO5	Adopt relevant ground improvement techniques to mitigate adverse geotechnical conditions	Apply
CO6	Adopt suitable soil stabilization techniques to enhance soil bearing capacity and stability	Apply

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		Terminal Examination
	1	2	
Remember	15	10	15
Understand	50	10	15
Apply	35	80	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-

Syllabus

Introduction to site investigation: Necessity of site investigation – Stages and Planning of site investigation – Depth and Lateral extent of Investigation for different types of structures – Methods of site investigation - Modern methods of boring and sampling – Samplers for disturbed and undisturbed sampling - Different disturbances in soil sampling - Preservation and transportation of samples. **Geophysical Exploration:** Electrical Resistivity method – Seismic Reflection and Seismic Refraction methods - Analysis and interpretation of test data – Limitations of Electrical Resistivity and Seismic methods. **Field Tests**: Plate Load Test – Pile load test – Field Vane Shear test – Field Permeability test - Analysis and interpretation of field test data. **In-situ Penetration Tests:** Standard penetration test – Static and Dynamic Cone penetration tests – Correlation of geotechnical parameters of soil with test results – Pressure meter test - Soil Profiling – Bore log - Report Preparation - Challenges in Field and In-situ Penetration tests. **Ground Improvement Techniques:** Requirements of ground improvement – Ground improvement methods - Selection of appropriate ground improvement method - Shallow compaction and deep compaction methods - Vibro compaction - Stone column - Preloading with sand drains - Application of Geosynthetics. **Soil Stabilization:** Stabilization of problematic soil - Chemical methods – Stabilization with lime and cement - Grouting - Deep soil mixing - Stabilization by thermal and freezing technique - Case Studies on Ground Improvement and Soil Stabilization methods

Course Content and Lecture Schedule

Module No.	Topics	No. of Lectures	Course Outcome
1	**Introduction to site investigation**		**CO1**
1.1	Necessity of site investigation – Stages and Planning of site investigation	1	
1.2	Depth and Lateral extent of Investigation for different types of structures	1	
1.3	Methods of site investigation - Modern methods of boring and sampling	1	
1.4	Samplers for disturbed and undisturbed sampling	1	
1.5	Different disturbances in soil sampling - Preservation and transportation of samples	1	
2	**Geophysical Exploration**		
2.1	Electrical Resistivity method	1	**CO2**
2.2	Seismic Reflection and Seismic Refraction methods	2	
2.3	Analysis and interpretation of test data	1	
2.4	Limitations of Electrical Resistivity and Seismic methods	1	
3	**Field Tests**		
3.1	Plate Load Test	1	**CO3**
3.2	Pile load test	1	
3.3	Field Vane Shear test	1	
3.4	Field Permeability test	1	
3.5	Analysis and interpretation of field test data	1	
4	**In-situ Penetration Tests**		

4.1	Standard penetration test	1	**CO4**
4.2	Static and Dynamic Cone penetration tests	2	
4.3	Correlation of geotechnical parameters of soil with test	1	
4.4	Pressure meter test	1	
4.5	Soil Profiling - Bore log - Report Preparation	1	
4.6	Challenges in Field and In-situ Penetration tests	1	
5	**Ground Improvement Techniques**		
5.1	Requirements of ground improvement	1	**CO5**
5.2	Ground improvement methods - Selection of appropriate	1	
5.3	Shallow compaction and deep compaction methods	1	
5.4	Vibro compaction - Stone column	1	
5.5	Preloading with sand drains	1	
5.6	Application of Geosynthetics	1	
6	**Soil Stabilization**		
6.1	Stabilization of problematic soil	1	**CO6**
6.2	Chemical methods	1	
6.3	Stabilization with lime and cement	1	
6.4	Grouting	2	
6.5	Deep soil mixing	1	
6.6	Stabilization by thermal and freezing technique	1	
6.7	Case Studies on Ground Improvement and Soil Stabilization methods	1	
	Total Hours	**36**	

References

1. Das, B.M., “Principles of Foundation Engineering”, Sixth Edition, India Edition, Thomson, 2012.
2. Tomlinson, M.J., “Foundation Design and Construction”, Prentice Hall, Seventh Edition, CBS Publishers & Distributors, Pvt., Ltd., 2010.
3. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers & Distributors, New Delhi, 2015.
4. Purushothama Raj. P, “Ground Improvement Techniques”, Laxmi Publications (P) Ltd, New delhi, 2019.
5. NPTEL Material: https://nptel.ac.in/courses/105108075/

Course Designer

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