`CURRICULUM AND DETAILED SYLLABI

FOR

M.E. DEGREE (Industrial Engineering) PROGRAMME

FIRST TO FOURTH SEMESTER COURSES
&
ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2018-2019 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Govt. Aided Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU
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DEPARTMENT OF MECHANICAL ENGINEERING

Vision:

"Be a globally renowned school of engineering in mechanical sciences"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfill the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of M.E. (Industrial Engineering)

Graduating Students of M.E. Industrial Engineering programme will have

Programme Outcomes (POs)		Graduate Attributes (GAs)
PO1.	An ability to apply knowledge of mathematics and science in solving problems	**Scholarship of Knowledge**
PO2.	An ability to design and conduct experiments, as well as to analyze and interpret data	**Critical Thinking**
PO3.	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	**Problem Solving**
PO4.	An ability to have the broad education necessary to understand the impact of engineering solutions in a global and societal context	**Research Skill**
PO5.	An ability to use the techniques, skills, and modern engineering tools necessary for industrial engineering practice	**Usage of modern tools**
PO6.	An ability to function effectively as an individual and as a member or a leader in diverse teams, and in multidisciplinary activities	**Collaborative and Multidisciplinary work**
PO7.	An ability to apply project, financial management principles and techniques individually/collaboratively in project planning, implementation and control	**Project Management and Finance**
PO8.	An ability to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	**Communication**
PO9.	An ability to engage in independent and life-long learning for personal and societal development	**Life-long Learning**
PO10.	An ability to understand the professional and ethical responsibility	**Ethical Practices and Social Responsibility**
PO11.	An Ability to make corrective measures and learn from the mistakes without depending on external feed back	**Independent and Reflective Learning**

Thiagarajar College of Engineering: Madurai-625015.

Department of Mechanical Engineering

M.E. DEGREE (Industrial Engineering) PROGRAMME

Scheduling of Courses

Sem.	**Theory Courses**					**Theory Cum Practical**	**Practical/Project**	
4th (15)							18IE480 Dissertation Phase - II 0:15	
3rd (15)	18IEPX0 **(PE)** 3:0	18XXGX0 **(OE)** 2:0					18IE380 Dissertation Phase - I 0:10	
2nd (21)	18IE210 Quality and Reliability Engineering **(PC)** 3:0	18IEPX0 **(PE)** 3:0	18IEPX0 **(PE)** 3:0	18IEPX0 **(PE)** 3:0	18PG250 Research Methodology and IPR **(CC)** 2:0	18IE260 Simulation and Modeling **(PC - TCP)** 2:1	18IE 270 Analytics Laboratory **(PC)** 0:2	18IE280 Mini Project 0:2
1st (17)	18IE110 Applied Statistics **(FC)** 3:0	18IE120 Optimization Techniques **(PC)** 3:0	18IE130 Industrial Engineering Systems **(PC)** 3:0	18IEPX0 **(PE)** 3:0		18IE160 Programming Essentials **(PC - TCP)** 2:1	18IE170 Industrial Engineering Laboratory **(PC)** 0:2	

Total Credits to be earned for the award of degree: 68

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2018-2019 onwards)

FIRST SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
18IE110	Applied Statistics	FC	3	0	-	3
18IE120	Optimization Techniques	PC	3	0	-	3
18IE130	Industrial Engineering Systems	PC	3	0	-	3
18IEPX0	Program Elective - 1	PE	3	0	-	3
THEORY CUM PRACTICAL						
18IE160	Programming Essentials	PC	2	0	2	3
PRACTICAL						
18IE170	Industrial Engineering Laboratory	PC	-	-	4	2
Total						**17**

FC- Foundation Core; PC- Programme Core; PE-Programme Elective; OE-Open Elective; AC-Audit Course; CC- Common Core

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2018-2019 onwards)

FIRST SEMESTER

zS. No	Course code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam**	Max. Marks	Terminal Exam	Total
THEORY								
1	18IE110	Applied Statistics	3	50	50	100	25	50
2	18IE120	Optimization Techniques	3	50	50	100	25	50
3	18IE130	Industrial Engineering Systems	3	50	50	100	25	50
4	18IEPX0	Program Elective-1	3	50	50	100	25	50
THEORY CUM PRACTICAL								
5	*18IE160	Programming Essentials	3	50	50	100	25	50
PRACTICAL								
6	18IE170	Industrial Engineering Laboratory	3	50	50	100	25	50

* Theory cum Practical course

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

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2018-2019 onwards)

SECOND SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
18IE210	Quality and Reliability Engineering	PC	3	0	-	3
18IEPX0	Programme Elective - II	PE	3	0	-	3
18IEPX0	Programme Elective - III	PE	3	0	-	3
18IEPX0	Programme Elective - IV	PE	3	0	-	3
18PG250	Research Methodology and IPR	CC	2	0	-	2
THEORY CUM PRACTICAL						
18IE260	Simulation and Modeling	PC	2	0	2	3
PRACTICAL						
18IE270	Analytics Laboratory	PC	-	-	4	2
18IE280	Mini Project	PC	-	-	4	2
Total						**21**

FC- Foundation Core; PC- Programme Core; PE-Programme Elective; OE-Open Elective; AC-Audit Course; CC- Common Core

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2018-2019 onwards)

THIRD SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
18IEPX0	Programme Elective - V	PE	3	0	-	3
18XXGX0	Open Elective	OE	2	0	-	2
PRACTICAL						
18IE380	Dissertation Phase - I	PC	-	-	10	10
Total						**15**

FC- Foundation Core; PC- Programme Core; PE-Programme Elective; OE-Open Elective; AC-Audit Course; CC- Common Core

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2018-2019 onwards)

FOURTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
18IE480	Dissertation Phase - II	PC	-	-	15	15
Total						**15**

FC- Foundation Core; PC- Programme Core; PE-Programme Elective; OE-Open Elective; AC-Audit Course; CC- Common Core

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
18PGAX0	Audit Course	AC	2	-	-	2
Total						**15**

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2018-2019 onwards)

SECOND SEMESTER

S. No	Course code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam**	Max. Marks	Terminal Exam	Total
THEORY								
1	18IE210	Quality and Reliability Engineering	3	50	50	100	25	50
2	18IEPX0	Programme Elective - II	3	50	50	100	25	50
3	18IEPX0	Programme Elective - III	3	50	50	100	25	50
4	18IEPX0	Programme Elective - IV	3	50	50	100	25	50
5	18PG250	Research Methodology and IPR	3	50	50	100	25	50
THEORY CUM PRACTICAL								
6	18IE260	Simulation and Modeling	3	50	50	100	25	50
PRACTICAL								
7	18IE270	Analytics Laboratory	3	50	50	100	25	50
8	18IE280	Mini Project	-	150	150	300	75	150

* Theory cum Practical course

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

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

M.E. DEGREE (Industrial Engineering) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2018-2019 onwards)

THIRD SEMESTER

S. No	Course code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam**	Max. Marks	Terminal Exam	Total
THEORY								
1	18IEPX0	Programme Elective - V	3	50	50	100	25	50
2	18XXGX0	Open Elective	3	50	50	100	25	50
PRACTICAL								
3	18IE380	Dissertation Phase - I	-	150	150	300	75	150

FOURTH SEMESTER

S. No	Course code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam**	Max. Marks	Terminal Exam	Total
PRACTICAL								
4	18IE480	Dissertation Phase - II	-	150	150	300	75	150

Audit Courses

S. No	Course code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment	Terminal Exam**	Max. Marks	Terminal Exam	Total
5	18PGAA0	Professional Authoring	-	100	-	100	-	50
6	18PGAB0	Value Education	-	50	50	100	25	50

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
M.E Degree (Industrial Engineering) PROGRAMME
CATEGORIZATION OF COURSES
(Choice Based Credit System)

Sl. No	Course Code	Name of the Course	Category	Credit
		Foundation Core		
1.	18IE110	Applied Statistics	FC	3
		Programme Core		
2.	18IE120	Optimization Techniques	PC	3
3.	18IE130	Industrial Engineering Systems	PC	3
4.	18IE210	Quality and Reliability Engineering	PC	3
		Theory cum Practical		
5.	18IE160	Programming Essentials	PC	3
6.	18IE260	Simulation and Modelling	PC	3
		Common Core		
7.	18PG250	Research Methodology and IPR	CC	2
		Programme Practical		
8.	18IE170	Industrial Engineering Laboratory	PC	2
9.	18IE270	Analytics Laboratory	PC	2
10.	18IE280	**Mini Project**	PC	2
11.	18IE380	**Dissertation Phase - I**	PC	10
12.	18IE480	**Dissertation Phase - II**	PC	15
		Programme Electives		
13.	18IEPA0	Computer Integrated Manufacturing	PE	3
14.	18IEPB0	Cost and Financial Management	PE	3
15.	18IEPC0	Industrial Automation	PE	3
16.	18IEPD0	Lean Manufacturing and Six Sigma	PE	3
17.	18IEPE0	Machine Learning	PE	3
18.	18MGPH0	Machine vision	PE	3
19.	18IEPG0	Maintenance Engineering and Risk Management	PE	3
20.	18IEPH0	Marketing Management	PE	3
21.	18IEPK0	Operations Management	PE	3

Sl. No	Course Code	Name of the Course	Category	Credit
22.	18MGPQ0	Plant Layout and Material Handling	PE	3
23.	18IEPM0	Robust Design	PE	3
24.	18IEPN0	Supply Chain Management	PE	3
25.	18IEPP0	Safety Engineering	PE	3
26.	18IEPQ0	Entrepreneurship Development	PE	3
27.	18IEPR0	Human Resource Management	PE	3
28.	18IEPS0	Project Management	PE	3
		Open Elective Courses		
29.	18MGGA0	Multi Objective Optimization	OE	2

List of Electives Passed

1.	18IEPB0	Cost and Financial Management	PE	3
2.	18IEPD0	Lean Manufacturing and Six Sigma	PE	3
3.	18IEPE0	Machine Learning	PE	3
4.	18MGPH0	Machine vision	PE	3
5.	18IEPG0	Maintenance Engineering and Risk Management	PE	3
6.	18IEPH0	Marketing Management	PE	3
7.	18MGPQ0	Plant Layout and Material Handling	PE	3
8.	18IEPM0	Robust Design	PE	3
9.	18IEPP0	Safety Engineering	PE	3
10.	18IEPQ0	Entrepreneurship Development	PE	3
11.	18IEPR0	Human Resource Management	PE	3
12.	18IEPS0	Project Management	PE	3
		Open Elective Courses		
13.	18MGGA0	Multi Objective Optimization	OE	2

		Category	L	T	P	Credit
18IE110	**APPLIED STATISTICS**	FC	3	0	0	3

Preamble

Post graduate students in engineering needs to have knowledge in mathematical techniques to apply in diverse applications in Engineering. This emphasizes the development of rigorous logical thinking, applying skills and the application of probability and statistics, in the field of Industrial Engineering. Based on this, the course aims at giving adequate exposure in understanding the application of statistics in engineering field.

Prerequisite

- Basic concepts of Probability

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Utilize random variables, distribution and density function, discrete and continuous distributions in industrial engineering	Apply	80	70
CO2.	Experiment with expectations and moment generating function technique and transformation of random variables	Apply	70	60
CO3.	Identify the correlation in linear and nonlinear forms and to apply the concept of least square method in fitting linear and nonlinear regression curves	Apply	70	60
CO4.	Develop the test of hypothesis for small and large samples by using various tests like t-test, F-test, z-test and chi-square test	Apply	80	70
CO5.	Apply the methods in multivariate analysis techniques and make use of Markov process in marketing strategy to predict market shares for future period	Apply	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	0	0
Understand	30	30	30	30

Apply	60	60	70	70
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe random variable with an example
2. A random variable X has the following probability distribution

x	-2	-1	0	1	2	3
p (x)	0.1	K	0.2	2k	0.3	3k

Find a) k b) P (X< 2) c) P (-2 < X < 2) d) Cumulative distribution function

3. If the probability of success is 1/100, how many trials are necessary in order that probability of at least one success is greater than 1/2?

Course Outcome 2 (CO2):

1. Identify the expectation where X is the outcome when we roll a die
2. Estimate the moment generating function of the random variable X given its probability density function is f(x) = 2 e^{-2x}; x > 0
3. Let X and Y be independent standard normal variables. Find the PDF of Z = X + Y

Course Outcome 3 (CO3):

1. Compute $R_{1.23}$ if $r_{12} = 0.77$; $r_{13} = 0.72$; $r_{23} = 0.52$

2. Calculate the correlation coefficient and the angle between the regression lines
   4x – 5y + 33 = 0 and 20x – 9y = 107
3. Determine the plane of regression of Y on X_1 and X_2 for the following data

Y :	90	72	54	42	30	12
X_1:	3	5	6	8	12	14
X_2:	16	10	7	4	3	2

Course Outcome 4 (CO4):

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 nicotine contents in two samples of tobacco are given below:

Sample 1:	21	24	25	26	27	-
Sample 2:	22	27	28	30	31	36

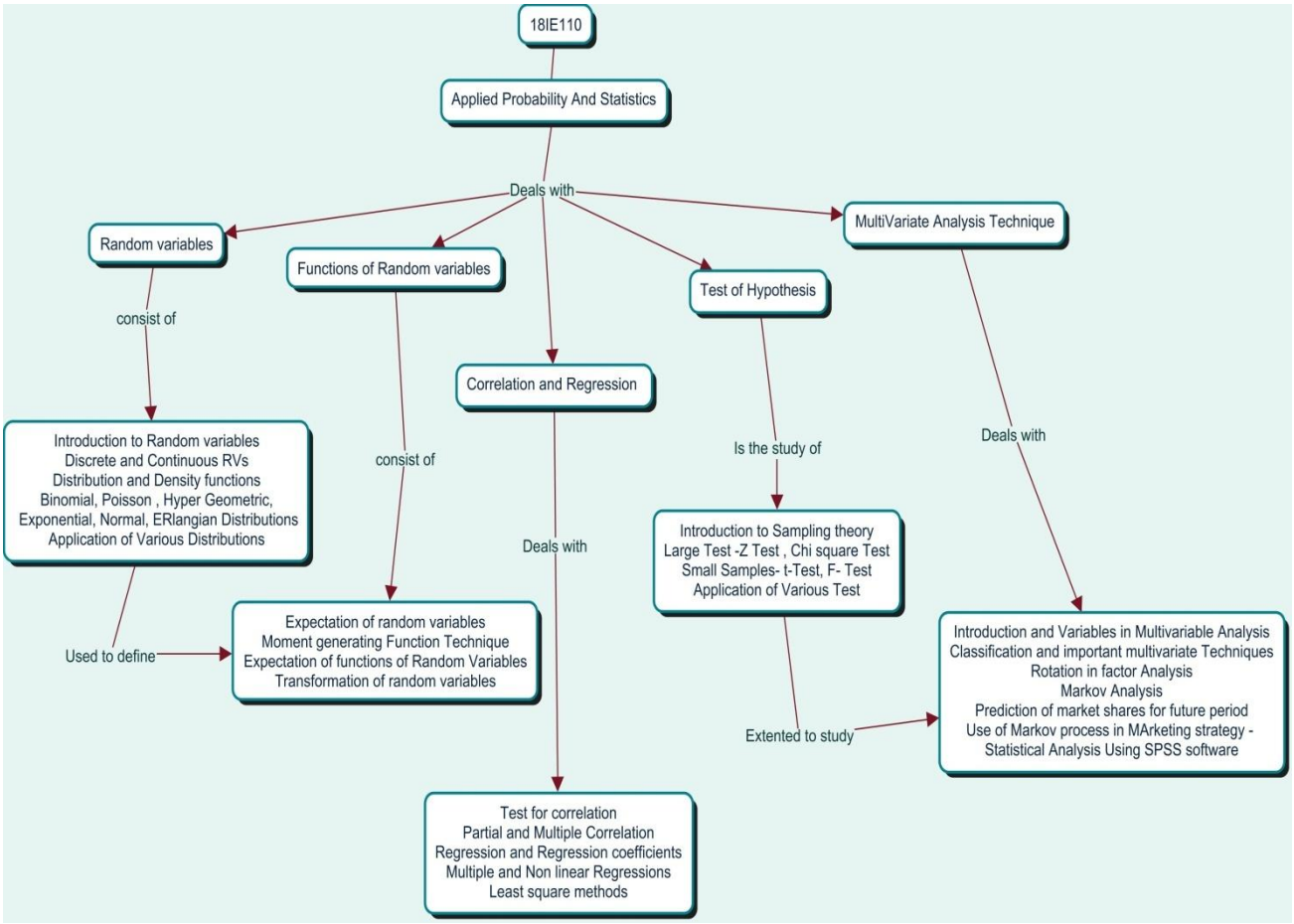
Can you say that the two samples came from the same normal population?

Course Outcome 5 (CO5):

1. Define multivariate analysis with suitable example
2. Discuss about rotation in factor analysis

3. A man is at an integral point on the x-axis between the origin and the point 3. He takes an unit step to the right with probability 1/3 or to the left with probability 2/3, unless he is at the origin, where he takes a step to the right to reach the point1 or is at the point 3, where he takes a step to the left to reach the point 2. What is the probability that (i) he is at the point 1 after 3 walks? and (ii) he is at the point 1 in the long run?

Concept Map



Syllabus

Random variables:

Introduction to Random Variables, Distribution and Density functions, Binomial, Poisson, Hyper Geometric, Exponential, Normal, Erlangian distributions, Application of various distributions.

Functions of random variables:

Expectation of random variables, moment generating function techniques, expectation of functions of random variables, Transformation of variable.

Correlation and Regression:

Test for Correlation, Partial and Multiple correlation, Regression and regression coefficients, Multiple and Non Linear regressions, Least Square methods.

Test of Hypothesis:

Introduction to sampling theory, large samples- Z test for proportions, means and standard deviation, chi-square tests, Small samples- t-test for proportions, means and for associated data, F-test for variances, uses of non parametric tests, Application of Various Tests.

Multivariate Analysis Techniques:

Introduction and variables in Multivariate Analysis, Classification and important multivariate Techniques, Rotation in factor analysis, Markov Analysis, Prediction of market shares for future period, Use of Markov process in marketing strategy - Statistical analysis using SPSS software.

Reference Books

1. Miller & Freund's, "Probability and Statistics for Engineers", Eighth Edition, Prentice Hall of India, 2010
2. Richard I.Levin, David S. Rubin, "Statistics for Management", Seventh Edition, Pearson Education, Singapore.
3. David R.Anderson, DennisJ.Sweeney, Thomas A.Williams, , " Statistics for Business and Economics", Eleventh Edition. 2010.
4. Damodar N. Gujarati, "Basic Econometrics", Fifth Edition, Mcgraw Higher Ed, New
5. J.N.Sharma, J.K.Goel, "Mathematical Statistics", Twenty Eighth Edition, Krishna Prakasham Mandir, Meerut, 2014.
6. T.W.Anderson," An Introduction to Multivariate Statistical Analysis", Third Edition, John Wiley & Sons, 2009.
7. Richard A.Johnson & Dean W.Wichern,"Applied Multivariate Statistical Analysis", Sixth Edition, Pearson, 2016

Course Contents and Lecture Schedule

Sl.No	Topics	No. of Lectures
1	**Random variables**	
1.1	Introduction to Random Variables	1
1.2	Discrete and Continuous RVs	1
1.3	Distribution and Density functions	1
1.4	Binomial, Poisson distributions	1
1.5	Hyper Geometric ,Exponential Distributions	1
1.6	Normal, Erlangian Distributions	2
1.7	Application of various Distributions	1
2	**Functions of Random variables**	
2.1	Expectation of random variables	1
2.2	Moment Generating Function Technique	1
2.3	Expectation of functions of Random Variables	2
2.4	Transformation of random variables	2

3	**Correlation and Regression**	
3.1	Test for Correlation	1
3.2	Partial and Multiple correlation	1
3.3	Regression and regression coefficients	1
3.4	Multiple and Non Linear regressions	2
3.5	Least Square methods	2
4	**Test of Hypothesis**	
4.1	Introduction to sampling theory	1
4.2	Large samples- Z test for proportions, means and standard deviation	2
4.3	chi-square tests	1
4.4	Small samples- t-test for proportions, means and for associated data	2
4.5	F-test for variances, uses of non parametric tests	1
4.6	Application of Various Tests	1
5	**Multivariate Analysis techniques**	
5.1	Introduction and variables in Multivariate Analysis	1
5.2	Classification and important multivariate Techniques	1
5.3	Rotation in factor analysis	1
5.4	Markov Analysis	2
5.5	Prediction of market shares for future period	1
5.6	Use of Markov process in marketing strategy - Statistical analysis using SPSS software.	1
	Total no. of hours	36

Course Designer

1. Dr.N.Chitra ncmat@tce.edu

		Category	L	T	P	Credit
18IE120	**OPTIMIZATION TECHNIQUES** (Common to 18MGPP0)	PC	3	0	0	3

Preamble

Optimization is a scientific approach to decision making that seeks to best design and operate a system, usually under conditions requiring the allocation of scarce resources. Various techniques of optimization have been dealt on the title “Operations Research”. Because of the complexity of most real-world optimization problems, it has been necessary for researchers and practitioners to reduce the complexity of the problem by either simplifying the problem or constraining it by making reasonable assumptions. Besides, the decisive factor is significant in bringing the products to market in order to guarantee profit in today’s challenging environment of manufacturing industries, with its changing needs, shorter product life cycle, and tighter deadlines. On this consideration, a major focus on the techniques and stratagems relevant to manufacturing applications has been given. Linear, integer and non-linear programming problems, and network models are addressed primarily. Further, intelligent search heuristics are introduced to appreciate the concepts so as to apply them in solving large-scale manufacturing problems.

Prerequisite

- Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Formulate mathematical models of Linear Programming (LP), Integer Programming (IP), Networks and Non-linear Programming (NLPP) problems.	Apply	70	60
CO2	Solve Linear Programming Problems (LPP) by appropriate techniques (i.e. Graphical, Simplex method) and evaluate the behaviour under different range of parameters.	Analyse	60	50
CO3	Solve Integer Programming Problems (IPP) using branch and bound, and cutting plane method	Apply	70	60
CO4	Examine the performance characteristics such as time and cost in solving shortest route, flow, transportation and assignment problems with an appropriate model	Analyse	60	50
CO5	Solve unconstrained and constrained Non-Linear Programming Problems (NLPP) using appropriate techniques.	Apply	70	60
CO6	Explain the concept and working of emerging intelligent search techniques such as Genetic Algorithm (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), and Simulated Annealing Algorithm (SAA).	Understand	80	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	-	10	-	5
Understand	20	10	20	10
Apply	60	60	40	45
Analyse	20	20	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. A company produces two types of goods A and B that require gold and silver. Each unit of type A requires 3 grams of silver and 1 gram of gold while B requires 1 grams of silver and 2 grams of gold. The company can produce 9 grams of silver and 8 grams of gold. If each unit of type A brings a profit of Rs.40 and that of type B Rs.50, determine the number of units of each type that should be produced to maximize the profit. Formulate the LP Model and find the optimal product mix and the corresponding profit of the company using simplex method.
2. A firm manufactures two products A and B on which the profits earned per unit are Rs. 3 and Rs. 4, respectively. Each product is processed on two machines M1 and M2. Product A requires one minute of processing time on M1 and two minutes on M2, while B requires one minute on M1 and one minute on M2. Machine, M1 is available for not more than 7 hours 30 minutes, while machine M2 available for 10 hours during any working day. Formulate the problem as LPP to find the number of units of products A and B to be manufactured to get maximum profit and solve this LPP using the result of the its dual problem.

3. Four factories, A, B, C and D produce sugar and the capacity of each factory is given below: Factory A produces 10 tons of sugar and B produces 8 tons of sugar, C produces 5 tons of sugar and that of D is 6 tons of sugar. The sugar has demand in three markets X, Y and Z. The demand of market X is 7 tons, that of market Y is 12 tons and the demand of market Z is 4 tons. The following matrix gives the transportation cost of 1 ton of sugar from each factory to the destinations. Develop a mathematical model for determining least cost transportation cost.

Factories.	*Cost in Rs. per ton (× 100) Markets.*			*Availability in tons.*
	X	*Y*	*Z*	
A	4	3	2	10
B	5	6	1	8

C	6	4	3	5
D	3	5	4	6
Requirement in tons.	7	12	4	

Course Outcome 2 (CO2):

1. A company produces both interior and exterior paints from two raw materials, M_1 and M_2.The following table 1 provides the basic data of the problem:

Table 1

	Tonnes of raw material per tonne of		
	Exterior Paint	Interior Paint	Maximum Daily Availability (Tonnes)
Raw Material, M1	6	4	24
Raw Material, M2	1	2	6
Profit per tonne(Rs.'000)	5	4	

A market survey indicates that the daily demand for interior paint cannot exceed that for exterior paint by more than 1 tonne. Also, the maximum daily demand for interior paint is 2 tonnes. The company wants to determine the optimum (best) product mix of interior and exterior paints that maximizes the total daily profit. Use simplex method to obtain the optimal solution.

2. The problem of maximising the overall profits for product mix with given the resource constraints is formulated as linear program given as: Maximise $Z = 3x_1 + 5x_2$; Subject to: $x_1 \leq 4$; $3x_1 + 2x_2 \leq 0$; $x_1, x_2 \geq 0$. The optimal table is given in Table 2.

Table 2

C_j		3	5	0	0	b_i
C_B	Basic Variables	x_1	x_2	S_1	S_2	
0	S_1	1	0	1	0	4
5	x_2	$\frac{3}{2}$	1	0	$\frac{1}{2}$	9
C_j-Z_j		$\frac{-9}{2}$	0	0	$\frac{-5}{2}$	Z = 45

If a new product (variable) x_3 is included in the existing product mix. The profit per unit of the new product is Rs. 7 and its rates of consumption in the constraints are 1 and 2, respectively. Check whether the inclusion of the new product changes the optimality and if it changes the optimality, find the revised optimal solution.

3. Solve the dual of the following LPP and determine the values of the primal decision variables.

Maximise $Z = 3x_1 + 2x_2$

Subject to constraints, $x_1 + x_2 \geq 1$

$x_1 + x_2 \leq 7$

$x_1 + 2x_2 \leq 10$

$x_1, x_2 \geq 0$

Course Outcome 3 (CO3):

1. A company manufacturer two types of products, P1 and P2. Each product uses lathe and milling machine. The processing time per unit of P1 on the lathe is 5 hours and on the milling machine is 4 hours. The processing time per unit of P2 on the lathe is 10 hours and on the milling machine is 4 hours. The maximum number of hours available per week on the lathe and milling machine are

60 hours and 40 hours, respectively. Also, profit per unit of selling P1 and P2 are Rs.6 and Rs.8, respectively. Formulate as integer programming model and determine the production volume of each of product such that the total profit is maximized.

2. Solve the following:

Maximise $Z = 5x_1 + 10x_2 + 8x_3$

Subject to $2x_1 + 5x_2 + x_3 \leq 10$

$x_1 + 4x_2 + 2x_3 \leq 12$

$x_1, x_2, x_3 \geq 0$ and are integers

3. Solve the following integer programming problem using Branch and Bound method.

Maximise $Z = 2x_1 + 3x_2$

Subject to $6x_1 + 5x_2 \leq 25$

$x_1 + 3x_2 \leq 10$

$x_1, x_2 \geq 0$ and are integers

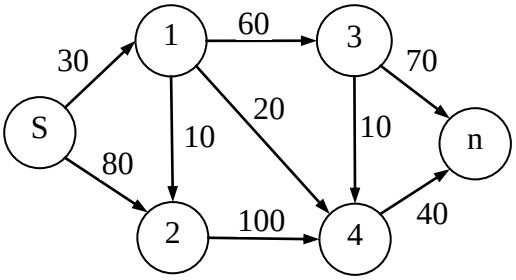
Course Outcome 4 (CO4):

1. A company has five jobs V, W, X, Y and Z and five machines A, B, C, D and E. The given matrix shows the return in Rs. of assigning a job to a machine. Assign the jobs to machines using Hungarian Method so as to maximize the total returns.

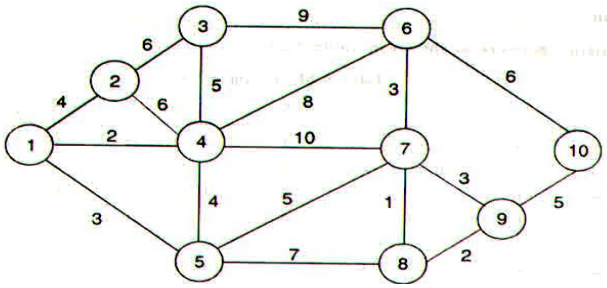
Machines. Returns in Rs.

Jobs	*A*	*B*	*C*	*D*	*E*
V	5	11	10	12	4
W	2	4	6	3	5
X	3	12	5	14	6
Y	6	14	4	11	7
Z	7	9	8	12	5

2. A network as shown in figure 3, has the maximum flow of 70 units between 'S' and 'n'. If the direction of the arc between nodes 1 and 4, has been reversed, is there any changes in the flow? If so, determine the revised maximum flow between the source, *S* to sink, *n* and justify the same.



3. A company is interested in laying telephone cable in an area with 10 major locations, as shown in figure. The number on each arc represents the distances between the nodes connected by the arc. Suggest the company to provide the optimal lay scheme to connect all the locations.



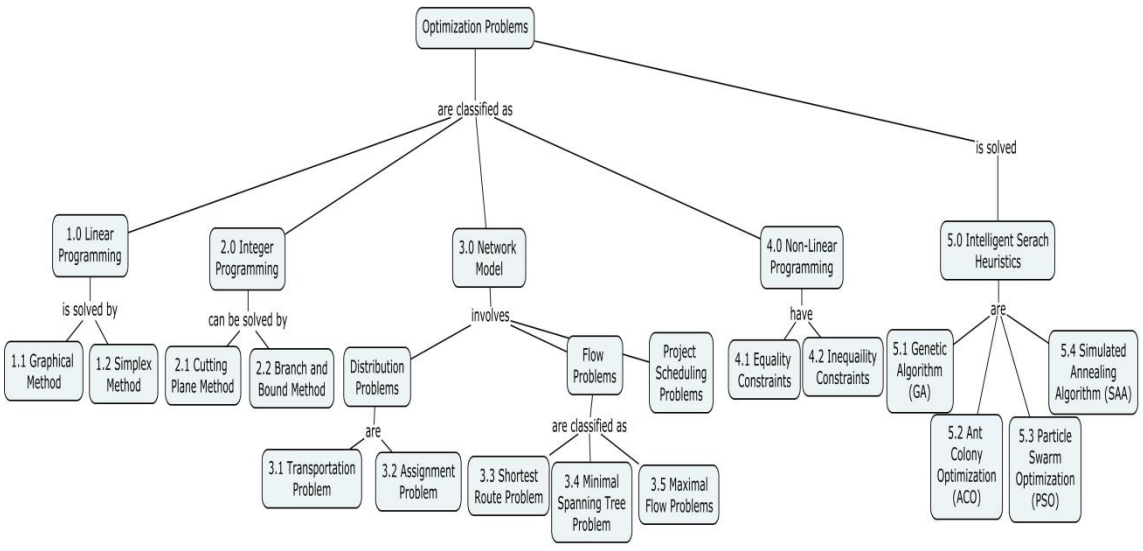
Course Outcome 5 (CO5):

1. Use Fibonacci search to: Maximize f(x) = $x^2 + \frac{54}{x}$; Subject to 0 ≤ x ≤ 5 with six evaluations and its final interval of uncertainty having a length less than 0.5.
2. Solve the following Non linear Programming Problem (NLPP),
   Minimise $z = x_1^2 + x_2^2 + x_3^2$
   Subject to, $4x_1 + x_2^2 + 2x_3 - 14 = 0$
3. Determine the value of x_1 & x_2 using Kuhn-Tucker's conditions
   Maximise $Z = 10\,x_1 - x_1^2 + 10x_2 - x_2^2$
   Subject to constraints, $x_1 + x_2 \leq 9$; $x_1 - x_2 \geq 6$

Course Outcome 6 (CO6):

1. Draw the flowchart for solving non-linear programming problem using Binary Genetic Algorithm and explain the step by step procedure with an illustration.
2. Explain the principle of Particle Swarm Optimization (PSO) and mention its advantages and limitations over Genetic Algorithm.
3. Discuss the parameters involved in Ant Colony Optimization (ACO) to solve the non-linear programming problem with constraints.

Concept Map



Syllabus

Linear Programming: Formulation - Graphical Method and Simplex Method – Primal Vs. Dual relationships - Sensitivity Analysis. **Integer Programming**: Formulation - Branch and Bound Method - Cutting Plane Method; **Network Model:** Network Construction – Terminologies - Transportation

problems – Solution using u-v method – Assignment problems – Solution using Hungarian Method - Shortest route problems, Minimal Spanning Tree problems, Maximal Flow problems; **Nonlinear Programming Nonlinear Programming (with Equality Constraints)** Lagrangian Multiplier - Equality constrained optimization -Projected Gradient Methods with equality constraints; **Nonlinear Programming (Inequality Constraints):** Khun concept - Khun Tucker conditions; **Intelligent search heuristics**: Concept – principle and parameters of Genetic Algorithm (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Simulated Annealing Algorithm (SAA).

Reference Books / Learning Resources

1. Winston, Wayne L, and Jeffrey B. Goldberg. Operations Research: Applications and Algorithms, 7th Edition, Thomson/Brooks/Cole Belmont, CA, 2004.
2. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, "Quantitative Methods for Business, Twelfth Edition, Cengage Learning, South-Western, 2013.
3. Ravindran, Don. T. Phillips, and James J. Solberg, "Operations Research - Principles and Practice", Second Edition, John Wiley and Sons, 2007.
4. Frederick Hillier, Gerald Lieberman, "Introduction to Operations Research" Tenth Edition, Tata McGraw Hill, 2015.
5. Hamdy A. Taha, "Operations Research - An Introduction", 7th Edition, MacMillan Co., 2010.
6. Kalyanmoy Deb, "Optimisation for Engineering Design – Algorithms and Examples",2nd Edition, Eastern Economy Edition, PHI Learning Pvt. Limited, New Delhi, 2012.

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
	Introduction to Optimisation techniques - Classification	1
1.0	Linear Programming – Concept – Applications - Formulation – Single Objective problems	2
1.1	Graphical Method	1
1.2	Simplex Method	2
1.2.1	Primal Vs. Dual relationships	1
1.2.2	Sensitivity Analysis	2
2.0	Integer Programming Problem (IPP) - Formulation	2
2.1	Cutting Plane Method	1
2.2	Branch and Bound Method	2
3.0	Network Model: Network Construction– Terminologies	1
3.1	Transportation problems – Solution using u-v method	2
3.2	Assignment problems – Solution using Hungarian Method	1
3.3	Flow Problems – Concepts – Terminologies - Shortest route problems	2
3.4	Minimal Spanning Tree problems	1
3.5	Maximal Flow problems	2
4.0	Nonlinear Programming (NLP) - Concepts – Terminologies – Classification - Constrained NLP Problems - Basic Concepts - Formulation	2
4.1	NLP problems with Equality Constraints - Basic Concepts- Applications	1
4.1.1	Lagrangian Multiplier Method	1

Module Number	Topic	No. of Lectures
4.2	NLP problems with Inequality Constraints - Basic Concepts – Applications – Formulation	1
4.2.1	Khun concept - Khun Tucker conditions	2
5.0	Intelligent search heuristics: Concept	1
5.1	Principle and parameters of Genetic Algorithm (GA)	1
5.2	Principle and parameters of Ant Colony Optimisation (ACO)	1
5.3	Principle and parameters of Particle Swarm Optimisation (PSO)	1
5.4	Principle and parameters of Simulated Annealing Algorithm (SAA)	1
Total		**35**

Course Designers:

1. B.Vellaikannan bvkmat@tce.edu
2. S. Saravana Perumaal sspmech@tce.edu

18IE130 INDUSTRIAL ENGINEERING SYSTEMS

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

Industrial engineering is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. Industrial engineers work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value. A system or component to function under stated conditions for a specified period of time. The Industrial Engineering Systems (IES) Course is designed to train engineers to organize and effectively utilize the total resources of modern manufacturing and process industries: materials, machinery, facilities, people, and capital.

Prerequisite

- NIL

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Describe the scope, objectives, application, of Industrial Engineering systems and Management	Understand	80	70
CO2.	Apply the various methods of Method study to Improve productivity	Apply	70	70
CO3.	Apply the various techniques of work measurement in manufacturing systems.	Apply	70	70
CO4.	Establish an efficient work system using ergonomics principles.	Apply	70	70
CO5.	Implement the value analysis techniques/ methodology to reduce the cost.	Apply	70	70
CO6.	Explain the role of maintenance management in material handling equipments.	Understand	80	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write the Scope and Objectives of Industrial Engineering Systems.
2. Explain the various methods and tools of Industrial Engineering Systems.

Course Outcome 2 (CO2):

3. Give various symbols of flow process chart and explain their significance. Draw a typical flow process chart. How does it differ from an operation chart? What are its Uses?
4. Apply the Principles of Motion Economy in process flow chart. How they are related to work place layout?
5. What are the various charting techniques available for recording a work method for analysis? Explain and apply with your own examples.
6. Describe the nature and uses of activity sampling.

Course Outcome 3 (CO3):

- The observed times and the performance ratings for the five elements are given

Element	1	2	3	4	5
Observed time (min.)	0.2	0.08	0.50	0.12	0.10
Performance rating	85	80	90	85	80

  Compute the standard time assuming rest and personal allowance as 15% and Contingency allowance as 2% of the basic time.

- A work sampling study was conducted to establish the standard time for an operation. The observations of the study conducted are given below:

  Total number of observations = 160
  Manual (hand controlled work) = 14
  Machine controlled work = 106
  Machine idle time = 40
  Average performance rating = 80%
  No. of parts produced = 36

Allowance for personal needs And fatigue = 10%

Study conducted for 3 days Available working hours/day = 8 hrs.

Calculate the standard time per piece.

3. In a Machine shop work sampling study was conducted for 160 hrs in order to estimate the standard time. Total numbers of observation recorded were 3500. There were 600 no working activities. Ratio between manual to machine element was 2:1 Average rating factor was 1:2 and total number of jobs produced during the study were 8000. Rest and personal allowances taken together will be 17% of normal time. Determine the standard time per job.

Course Outcome 4 (CO4):

1. Suggest the possible ways to improve your work place through ergonomics.
2. Apply the concept of Man – Machine systems to better environment in work place.

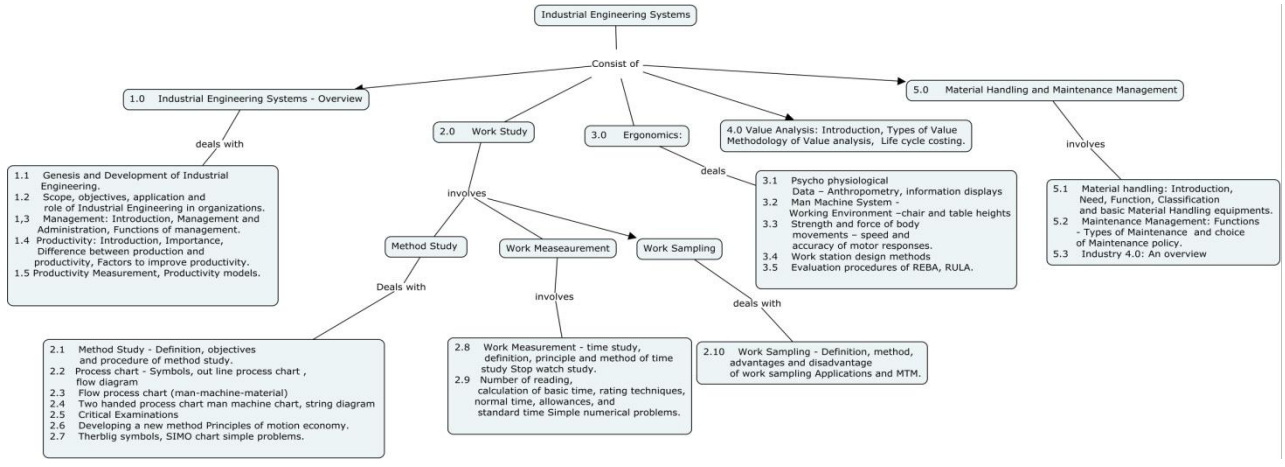
Course Outcome 5(CO5):

1. How will you implement the value analysis techniques in manufacturing sectors?
2. How would you determine the costs required to accomplish various functions of a product? Explain with an example.
3. Explain how the low cost promising ideas for various customer desired functions combined together to develop a number of workable solutions.

Course Outcome 6 (CO6):

1. Differentiate between break down maintenance and Preventive maintenance.
2. Explain different types of maintenance systems.
3. Illustrate the basic material handling equipments with suitable example
4. Describe the criteria and guidelines for the design of Unit load system.
5. Discuss about AS/AR system in comparison with the conventional warehousing system with an example.
6. Discuss about the choice of material handling system for a heavy manufacturing industry. Illustrate the pros and cons of the system under study.

Concept Map



Syllabus

Industrial Engineering Systems – Overview, Genesis and Development of Industrial Engineering. - scope, objectives, application and role of Industrial Engineering in organizations. **Management:** Introduction, Management and Administration, Functions of management. **Productivity:** Introduction, Importance, Difference between production and productivity, Factors to improve productivity, Productivity measurement, Productivity models.

Work Study: Method Study: - Definition, Objectives and Procedure of method study. Process Chart - Symbols, Outline Process Chart, Flow Diagram, Flow Process Chart (Man-Machine-Material), Two Handed Chart, Man-Machine chart, String Diagram and Critical examination. Developing a new method Principles of motion economy. Therblig symbols, SIMO chart simple problems. **Work Measurement** - time study, definition, principle and method of time study Stop watch study - number of reading, calculation of basic time, rating techniques, normal time, allowances, and standard time Simple numerical problems. **Work Sampling** - Definition, method, advantages and disadvantage of work sampling, Applications and MTM.

Ergonomics: Psycho physiological Data – Anthropometry, information displays – Man Machine System - Working Environment –chair and table heights. Strength and force of body movements – speed and accuracy of motor responses. Work station design methods, Evaluation procedures of REBA, RULA.

Value Analysis: Introduction, Types of Value, Methodology of Value analysis, Life cycle costing.

Material handling: Introduction, Need, Types and Function, Classification, Basic material handling equipments, **Maintenance Management:** functions - Types of Maintenance and choice of Maintenance policy. **Industry 4.0:** An overview

Reference Books

1. Khan, M.I, “Industrial Engineering”, New Age International, 2nd Edition, 2009.
2. Khanna, O.P, “Industrial Engineering and Management”, Dhanpat Rai and Sons, 2008.
3. Industrial Engineering and Organization Management, S K Sharma and Savita Sharma, S K Kataria& Sons, Edition 1, 2011.
4. Martand T Telsang, “Industrial Engineering and Production Management” S. Chand Publishing, 1999.
5. Prasad L.M., "Principles and Practice of Management", Sultan Chand & Sons, Eight edition, 2013
6. Harold Koontz, "Essentials of Management", Tata McGraw-Hill Education, Eighth edition 2010
7. Ralph M. Barnes, "Motion and Time Study: Design and Measurement of Work", John Wiley & Sons, 7th Edition, 1980.

8. Mukhopadhyaya, Anil Kumar, "Value engineering", Response Books, New Delhi ,2009, ISBN: 0-7619-9788-1
9. Pannerselvam,R, “Production and Operations Management”, Prentice Hall of India, Third Edition, 2012
10. Gopalakrishnan, P. Banerji, A.K, “Maintenance and Spare Parts Management”, Prentice Hall of India, 2011.
11. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.
12. NPTEL Video Lectures – Industrial Engineering, Prof.H.S.Shan, Prof.Pradeep Kumar, Prof. P. K. Jain, IIT-ROORKEE. URL: http://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/INDUSTRIAL-ENGINERRING/

Course Contents and Lecture Schedule

Sl.No.	Topics	No. of Periods
1.0	**Industrial Engineering Systems - Overview**	
1.1	Genesis and Development of Industrial Engineering.	1
1.2	Scope, objectives, application and role of Industrial Engineering in organizations.	1
1,3	**Management:** Introduction, Management and Administration, Functions of management.	2
1.4	**Productivity:** Introduction, Importance, Difference between production and productivity, Factors to improve productivity.	1
1.5	Productivity measurement, Productivity models	2
2.0	**Work Study:**	
2.1	**Method Study** - Definition, objectives and procedure of method study.	1
2.2	Process Chart-Symbols, Outline Process Chart, Flow diagram	1
2.3	Flow process chart (man, machine and material)	1
2.4	*Two Handed Process Chart, Man - Machine chart, String Diagram*	2
2.5	*Critical examination*	1
2.6	Developing a new method Principles of motion economy.	1
2.7	Therblig symbols, SIMO chart ,Simple Problems.	2
2.8	**Work Measurement** - Time study, definition, principle and method of time study - Stop watch study.	1
2.9	Number of reading, calculation of basic time, Rating techniques, normal time, allowances, and standard time, Simple numerical	2

	problems.	
2.10	**Work Sampling** - Definition, method, advantages and disadvantage of work sampling, Applications, MTM.	2
3.0	**Ergonomics:**	
3.1	Psycho physiological Data - Anthropometry, information displays	1
3.2	Man Machine System - Working Environment –chair and table heights	2
3.3	Strength and force of body movements -speed and accuracy of motor responses.	1
3.4	Work station design methods	1
3.5	Evaluation procedures of REBA, RULA.	2
4.0	**Value Analysis:** Introduction, Types of Value, Methodology of Value analysis, Life cycle costing.	2
5.0	**Material Handling and Maintenance Management**	
5.1	**Material handling:** Introduction, Need, Function, Classification and basic Material Handling equipments.	2
5.2	**Maintenance Management:** Functions - Types of Maintenance and choice of Maintenance policy.	2
5.3	**Industry 4.0:** An overview	2
	Total	**36**

Course Designers:

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		Category	L	T	P	Credit
18IE160	**PROGRAMMING ESSENTIALS**	PC	2	0	2	3

Preamble

This course facilitate the needs of learners of Industrial engineering, who need to learn Python through object oriented programming and to learn GUI based applications development. In this course, the user will be able to practice through programs in Python with the basic programming constructs and object oriented programming constructs. The users also have an opportunity to design a GUI based application using Python.

Prerequisite

- Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Practice the basic programming constructs such as operators, statements, conditions, loops, Arrays and Strings	Apply	70	80
CO2	Practice functions with arguments and default values	Apply	70	80
CO3	Practice the object oriented programming constructs such as abstraction, encapsulation, inheritance and polymorphism	Apply	70	70
CO4	Apply Tuples, Lists, Mutability, Sets, and Dictionary through python programming for the given application scenario	Apply	70	70
CO5	Design a simple GUI for the given scenario	Apply	70	80

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment (50)				Terminal Examination (50)
	CAT1 (10)	CAT2 (10)	Observation (10)	Practical Test (20)	
Remember	20	20	0	0	20
Understand	40	40	40	20	30
Apply	40	40	60	80	50
Analyse	0	0	0	0	0
Evaluate	0	0	0	0	0
Create	0	0	0	0	0

Course Level Assessment Questions

Course Outcome 1, 2 (CO1, CO2):

1. Show the memory model of variables in python.
2. Write a python program to check whether a given number is prime or not using for-else statement.
3. Write a python program to read the string with punctuations and print the same string without punctuations.
4. Write a python program to calculate the factorial of a number (a non-negative integer). The function accepts the number as an argument.
5. Write a python program that accepts a string and calculate the number of upper case letters and lower case letters.

Course Outcome 3 (CO3):

1. Illustrate the steps that python follows in creating objects.
2. In the Company Payroll Program, develop the classes and objects for calculating pay for the employees.
3. Define a class and create objects for an electricity billing problem.
4. Implement inheritance for an industry automation application.

Course Outcome 4 (CO4):

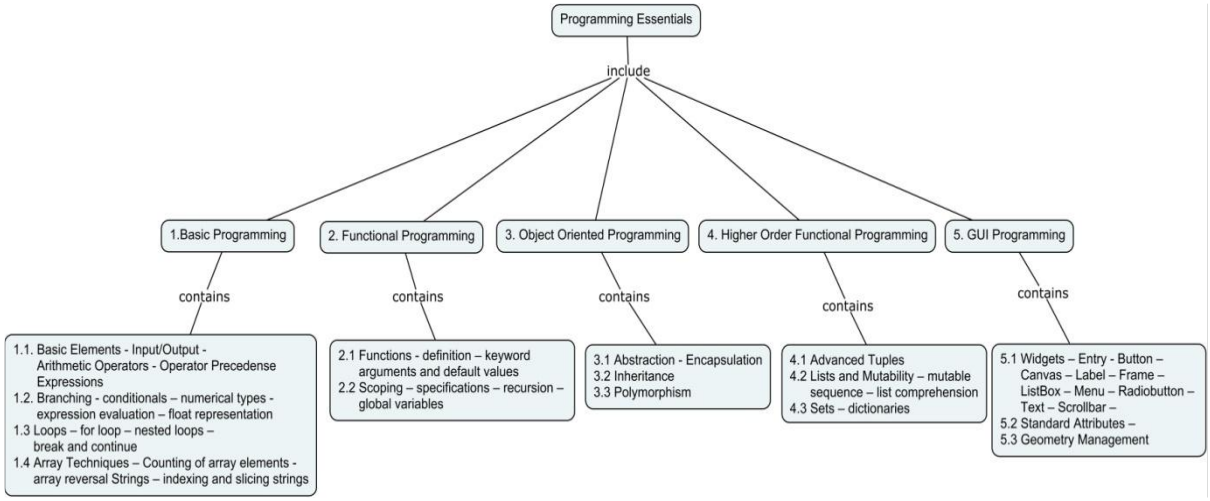
1. Show the difference between lists and string in python programming with an example.
2. Write a python program to read a word and print the number of letters, vowels, and percentage of vowels in the word using dictionary.
3. Store the following data in a list, in a set and in a dictionary

India	USA	UK	Japan
99	1	5	60

Course Outcome 5 (CO5):

1. Design a job application form for a company
2. Demonstrate various UI components such as Button, Label etc

Concept Map



Syllabus

Basic Programming – The basic elements of python –Input/Output - arithmetic operators – operator precedence – expressions – Branching – conditionals – numerical types - expression evaluation – float representation – loops – for loop – nested loops – break and continue – Array Techniques – Counting of array elements - array reversal Strings – indexing and slicing strings
Functional Programming - Functions - definition – keyword arguments and default values – scoping – specifications – recursion – global variables
Object Oriented Programming Constructs – Abstraction – Encapsulation – Inheritance – Polymorphism
Higher order functional Programming - Advanced Tuples – Lists and Mutability – mutable sequence – list comprehension – sets – dictionaries
GUI Programming – Widgets – Entry - Button – Canvas – Label – Frame – ListBox – Menu – Radiobutton – Text – Scrollbar – Standard Attributes – Geometry Management

Reference Books

1. John V.Guttag, “Introduction to Computation and Programming using Python”, The MIT Press, Cambridge Massachusetts, London, England, 2013.
2. Burkhard Meier, Python GUI Programming Cookbook, PACKT-Open Source, 2015.
3. https://www.python.org/doc/
4. **http://effbot.org/tkinterbook/**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	Basic Programming	
1.1	The basic elements of python –Input/ Output - arithmetic operators – operator precedence – expressions	1
1.2	Branching conditionals – numerical types - expression evaluation – float representation	2
1.3	loops – for loop – nested loops – break and continue	1
1.4	Array Techniques – Counting of array elements - array reversal Strings – indexing and slicing strings	2
2	Functional Programming	
2.1	Functions - definition – keyword arguments and default values	1
2.2	scoping – specifications – recursion – global variables	1
3	Object Oriented Programming Constructs	
3.1	Abstraction – Encapsulation	2
3.2	Inheritance	2
3.3	Polymorphism	2
4	Higher order functional Programming	
4.1	Advanced Tuples	1
4.2	Lists and Mutability - mutable sequence - list comprehension	2
4.3	Sets – dictionaries	2
5	GUI Programming	
5.1	Widgets – Entry - Button – Canvas – Label – Frame – ListBox – Menu – Radiobutton – Text – Scrollbar	1
5.2	Standard Attributes	2
5.3	Geometry Management	2
	TOTAL	24

Practical Component

S.No	List of activities	No. of hours
1	Simple basic programs a) Factorial b) Fibonacci c) Prime numbers d) Sorting and searching	4
2	Modular Programs a) Matrix addition and multiplications b) String manipulations	4
3	OOP Programs a) Encapsulation b) Inheritance c) Polymorphism	4
4	Higher order functional Programs a) Tuples b) Lists and Mutability	4
5	Higher order functional Programs a) Set b) Dictionary	4
6	GUI Programs a) Practice the widgets – Button, Label etc b) Design a simple form	4
	Total	**24**

Course Designer:

1. Dr.P.Karthikeyan, Asso.Prof-IT karthikit@tce.edu

		Category	L	T	P	Credit
18IE170	**INDUSTRIAL ENGINEERING LABORATORY**	PC	0	0	4	2

Preamble

'**Industrial Engineer**' is synonymous with **Systems Integrator** - a big-picture thinker, in other words. It's an employee who takes what exists today and conceptualizes what should exist in the future. Many people are misled by the term "Industrial Engineer." The word 'Industrial" does not mean just manufacturing. It encompasses wide span of industries ranging from FMCG, IT & System, Consultancy, Banking & Financial Institution and to Telecom.

With era of management growing from Scientific Principles to Strategic Concept companies adopt management philosophies of continuous productivity and quality improvement to survive in the increasingly competitive world market, the need for Industrial Engineers is growing.

This Laboratory is focusing on optimization and quality related practices for the student.

Prerequisite

- NIL

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO 1.	Evaluate the proposals for the given optimization problem using optimization packages/Spread sheet.	Evaluate	70	80
CO 2.	Analyze the given work practice by method study and work measurement	Analyze	70	80
CO 3.	Analyze the working posture of the employee (Ergonomics)	Analyze	70	80

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	S	S	M				M	
CO2	S	S	S	S	S	M				M	
CO3	S	S	S	S	S	M				M	

S- Strong; M-Medium; L-Low

Syllabus

List of Experiments

1. Formulation of linear regression model for the given data using spread sheet.
2. Interpretation of the proposed solution for the given linear programming problem using manual calculations and verify the solutions by using spread sheet application.
3. Evaluation of the proposals for the travelling salesman problem using LINGO software.
4. Evaluation of the proposals for the vehicle routing problem using LINGO software.
5. Evaluation of the proposals for the quadratic assignment problem using LINGO software.
6. Evaluation of the proposals for the given capacitated plant location problem using LINGO software.
7. Evaluation of the Priority rules , two machine n job scheduling problem using spread sheet.
8. Analysis of the working methods using different charting techniques in method study.
9. SIMO Chart Analysis
10. Evaluation of individual operator performance using different rating methods.
11. Computation of standard time using Stop watch time study.

12. Computation of standard time for the given job using Work sampling techniques
13. MTM practice
14. Study of physical performance using tread mill and Ergo cycle
15. Working posture analysis using REBA and RULA Chart
16. Collection of data from various sources related to Industrial Applications and Analysis of data.

Course Designers:

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		Category	L	T	P	Credit
18IEPA0	**COMPUTER INTEGRATED MANUFACTURING**	PE	3	0	0	3

(Common to 18MGPC0)

Preamble

Computer Integrated Manufacturing (CIM) is a manufacturing approach of using computers to control the entire production process. The integration of all elements of CIM environment allows individual process to exchange information with other elements and initiate actions. These activities encompass all functions necessary to translate customer needs into a final product. It includes computer aided design (CAD), computer aided manufacturing (CAM), computer aided process planning (CAPP), computer numerical control machine tools, computer integrated production management system and other business functions integrated by a common data base.

Prerequisite

- NIL

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Develop solid models using B-rep. scheme, CSG technique and sweep representation technique	Apply	70	60
CO2	Write offline program for simulating the machining operation	Apply	70	60
CO3	Explain the concept of computer data communication, Protocol and graphics standards	Understand	80	70
CO4	Explain the structure of CAPP, factory data collection system, and principle of lean and agile manufacturing	Understand	80	70
CO5	Demonstrate the working of material requirement planning	Apply	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	60	50	50
Apply	40	20	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

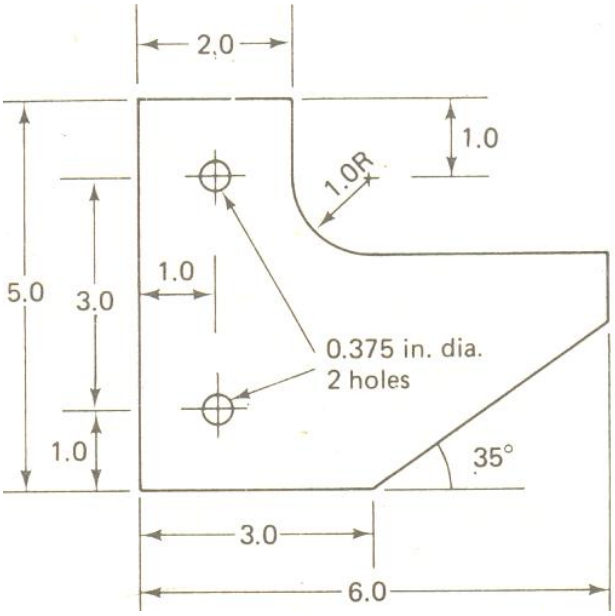
Course Level Assessment Questions

Course Outcome 1 (CO1):

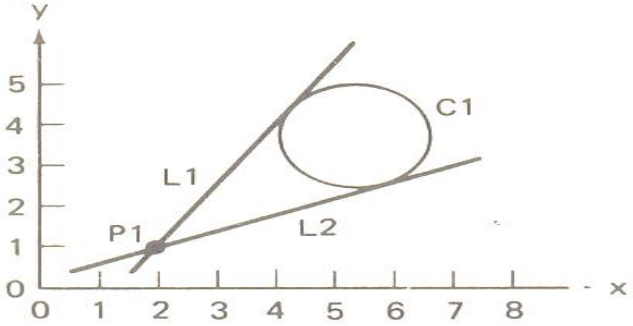
1. Develop a solid model of hollow cylinder of 15 mm thickness with inner diameter of 20 mm using sweep representation technique.
2. Suggest a suitable manipulation technique for joining two different solids.
3. Illustrate the Boundary representation and CSG technique with suitable solid model and compare the complexity of the two techniques used

Course Outcome 2 (CO2):

1. Write an APT program for milling the part as shown in the following figure.



2. Develop an APT code for 12 mm diameter drill at centre of a MS plate of size 20 x 40 mm with 3 mm thickness.
3. Write an APT codes for describing lines 1 and 2 shown in the following figure.



Course Outcome 3 (CO3):

1. Develop IGES neutral format for circle of radius 20 mm with centre (10, 5, 0) and a straight line with two ends (0, 0) and (15, 25).
2. Develop DXF neutral format for a point located at (10, 2, 8) and circle of diameter 40 mm with (0, 0, 0) as centre.
3. Explain the general procedure for framing of data along with the types of data error.

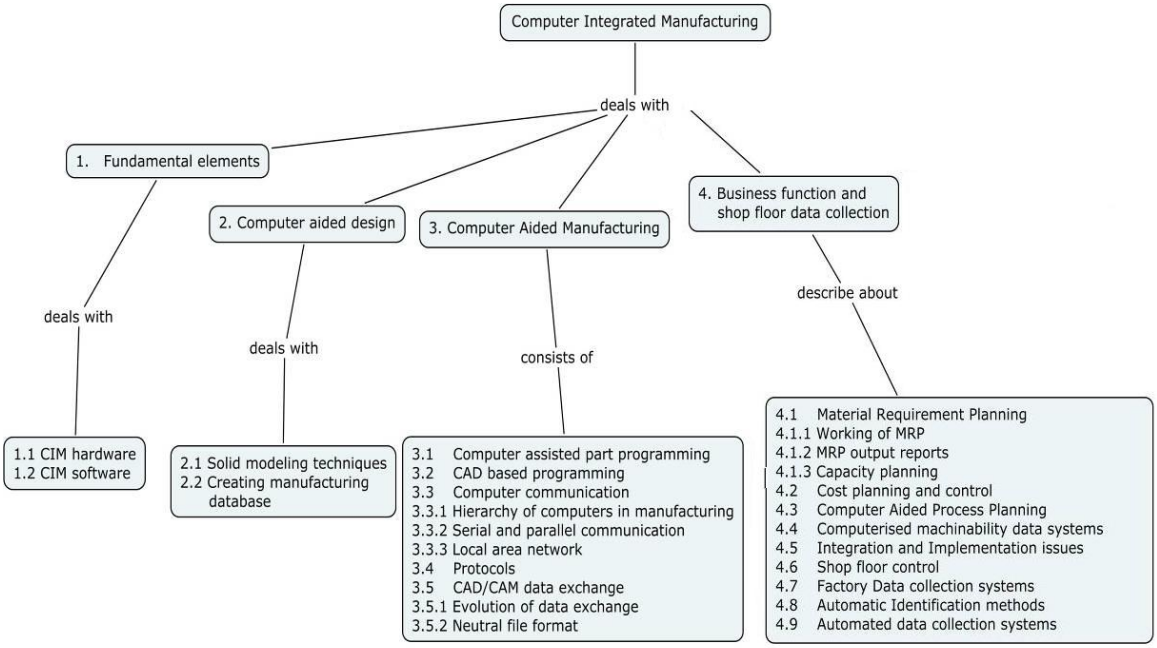
Course Outcome 4 (CO4):

1. Explain the concept of Generative type CAPP.
2. Describe about the computerised machinability data systems.
3. Discuss about the integration and implementation issues of CAPP and its advantage and limitation.

Course Outcome 5 (CO5):

1. Illustrate the principle of MRP functioning with suitable master scheduling data.
2. Suggest a suitable data collection method for mass production of oil seal and explain.
3. Discuss about any two automatic identification methods generally followed in a job shop production environment.

Concept Map



Syllabus

Fundamentals Elements: Nature of CIM, Evolution of CIM, CIM hardware and software. **Computer Aided Design:** Design process, solid modeling techniques, creating manufacturing database. **Computer Aided Manufacturing:** Elements of CNC machine tools, Offline program through APT language for machining operation, CAD based programming, **Computer Communication:** Hierarchy of computers in manufacturing, Serial and parallel communication, Local area network, **Protocols:** Manufacturing Automation Protocol and Technical Office Protocol, CAD/CAM data exchange-Method of data exchange, Evolution of data exchange, **Neutral file format:** DXF, IGES and PDES. **Business function and shop floor data collection:** Material Requirement Planning, Inputs to MRP, Working of MRP, MRP output reports, Capacity Planning, Cost planning and control, **Computer Aided Process Planning:** Retrieval type and Generative type CAPP, Benefits, Computerised machinability data

systems, Integration and Implementation issues, **Shop floor control:** Functions, information flow, Factory Data collection systems, Automatic Identification methods, automated data collection systems.

Reference Books

1. Vajpayee S. Kant, “Principles of Computer Integrated Manufacturing”, Prentice Hall of India Learning, 2009.
2. Ibrahim Zeid, “Mastering CAD/CAM”, Tata McGraw Hill Education (P) Ltd., Special Indian Edition, 2008.
3. Mikell P. Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, Pearson Publisher, Fourth Edition, 2016.
4. M. Groover, E. Zimmers, “CAD/CAM: Computer-Aided Design and Manufacturing”, Pearson Publisher, First Edition, 2003.
5. K.C. Jain and Sanjay Jain, “Principles of Automation and Advanced Manufacturing Systems”, Khanna Publishers, First Edition, 2003.

Course Contents and Lecture Schedule

Module Number	Topics	No. of Lectures
1.	**Fundamentals Elements:** Nature of CIM, Evolution of CIM	1
1.1	CIM hardware	1
1.2	CIM software	
2.	**Computer Aided Design:** Design process	1
2.1	Solid modeling techniques	2
2.2	Creating manufacturing database	1
3.	**Computer Aided Manufacturing:** Elements of CNC machine tools	1
3.1	Structure of APT offline program	1
	Offline program through APT language for machining operation	2
3.2	CAD based programming	1
3.3	Computer Communication	1
3.3.1	Hierarchy of computers in manufacturing	1
3.3.2	Serial and parallel communication	1
3.3.3	Local area network	
3.4	Protocols-Manufacturing Automation Protocol and Technical Office Protocol	1
3.5	CAD/CAM data exchange-Method of data exchange	1
3.5.1	Evolution of data exchange	1
3.5.2	Neutral file format-DXF, IGES and PDES	2
4.	**Business function and shop floor data collection**	
4.1	Material Requirement Planning-Inputs to MRP	2
4.1.1	Working of MRP	2
4.1.2	MRP output reports	1
4.1.3	Capacity Planning	
4.2	Cost planning and control	1
4.3	Computer Aided Process Planning-Retrieval type	1
	Generative type CAPP, Benefits of CAPP	1

Module Number	Topics	No. of Lectures
4.4	Computerised machinability data systems	1
4.5	Integration and Implementation issues	1
4.6	Shop floor control-functions, information flow	1
4.7	Factory Data collection systems	2
4.8	Automatic Identification methods	2
4.9	Automated data collection systems	2
	Total	36

Course Designers

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		Category	L	T	P	Credit
18IEPC0	**INDUSTRIAL AUTOMATION**	PC	3	0	0	3

(Common to 18MG130)

Preamble

Automation is a technology concerned with the application of mechanical, electronic, and computer-based systems to operate and control production. Automation and Robotics are two closely related technologies. This course aims at learning the basics of automation, , Automated Materials Handling and Storage Systems, Robot Anatomy and its industrial applications.

Prerequisite

- Nil

Course Outcomes

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

CO .No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Explain the principles, types of automation, production systems, management support systems and material handling equipment used for automation.	Understand	80	70
CO2	Explain the basic components and their functions of automated production line, automated assembly system.	Understand	80	70
CO3	Analyze the cycle time, process time, indexing time of indexing devices, efficiency of the production line, production rate and production cost.	Analyse	70	60
CO4	Analyse manual and automated assembly systems.	Analyse	70	60
CO5	Determine the gripper force of robotic arm.	Apply	70	60
CO6	Select the suitable layout, material handling devices and sensors for various industrial applications.	Apply	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Learning Objectives

Course Outcome 1 (CO1):

1. Define production system.
2. Name four conditions under which automated production lines are appropriate.
3. Explain briefly three problem areas that must be considered in the analysis and design of an automated production line.

Course Outcome 2 (CO2):

1. Discuss the hardware used in parts delivery system.
2. Analyse the several possible layouts of the in-line configuration of an automated production line.
3. Discuss the three basic control functions that must be accomplished to operate an automated production line.

Course Outcome 3 (CO3):

1. A rotary work table is driven by a Geneva mechanism with 5 slots. The driver rotates at 48 rev/min. Determine (a) cycle time, (b) available process time, and (c) indexing time.
2. A 30- station transfer line has an ideal cycle time of 0.75 min, an average downtime of 6.0 min per line stop occurrence, and a station failure frequency of 0.01 for all stations. A proposal has been submitted to locate a storage buffer between stations 15 and 16 to improve line efficiency. Determine (a) the current line efficiency and production rate that would result from installing the storage buffer.
3. A machine tool builder submits a proposal for a 20-station transfer line to machine a certain component currently produced by conventional methods. The proposal states that the line will operate at a production rate of 50 pieces per hour at 100% efficiency. On similar transfer lines, the probability of station breakdown per cycle is equal for all stations and p=0.005 breakdowns/cycle. It is also estimated that the average downtime per line stop will be 0.8min. The starting casting that is machined on the line costs Rs.120 per part. The line operates at a cost of Rs.4000 per hour. The 20 cutting tolls (one tool per station) last for 50 parts each, and the average cost per tool = Rs80 per cutting edge. Based on this data, compute (a) production rate, (b) line efficiency, and (c) cost per unit piece produced on the line.

Course Outcome 4 (CO4):

1. A synchronous assembly machine has 8 stations and must produce at a rate of 400 completed assemblies per hour. Average downtime per jam is 2.5 minutes. When a breakdown occurs, all subsystems (including the feeder) stop. The frequency of breakdowns of the machine is once every 50 parts. One of the eight stations is an automatic assembly operation that uses a feeder-selector. The components fed into the selector can have any of five possible orientations, each with equal probability, but only one of which is correct for passage into the feed track to the assembly

workhead. Parts rejected by the selector are fed back into the hopper. What minimum rate must the feeder deliver components to the selector during system uptime in order to keep up with the assembly machine?

2. A six-station automatic assembly machine has an ideal cycle time of 12 sec. Downtime occurs for two reasons. First, mechanical and electrical failures of the workheads occur with a frequency of once per 50 cycles. Average downtime for these causes is 3 minutes. Second, defective components also result in downtime. The fraction defect rate of each of the six components added to the base part at the six stations is q = 2%. The probability that a defective component will cause a station jam is m = 0.5 for all stations. Downtime per occurrence for defective parts is 2 minutes. Determine: (a) yield of assemblies that are free of defective components, (b) proportion of assemblies that contain at least one defective component, (c) average production rate of good product, and (d) uptime efficiency.
3. A single station robotic assembly system performs a series of five assembly elements, each of which adds a different component to a base part. Each element takes 6 seconds. In addition, the handling time needed to move the base part into and out of position is 4 seconds. For identification, the components, as well as the elements which assemble them, are numbered 1, 2, 3, 4, and 5. The fraction defect rate q = 0.005 for all components, and the probability of a jam by a defective component m = 0.7. Average downtime per occurrence = 5.5 minutes. Determine: (a) production rate, (b) yield of good product in the output, (c) uptime efficiency, and (d) proportion of the output that contains a defective type 3 component.

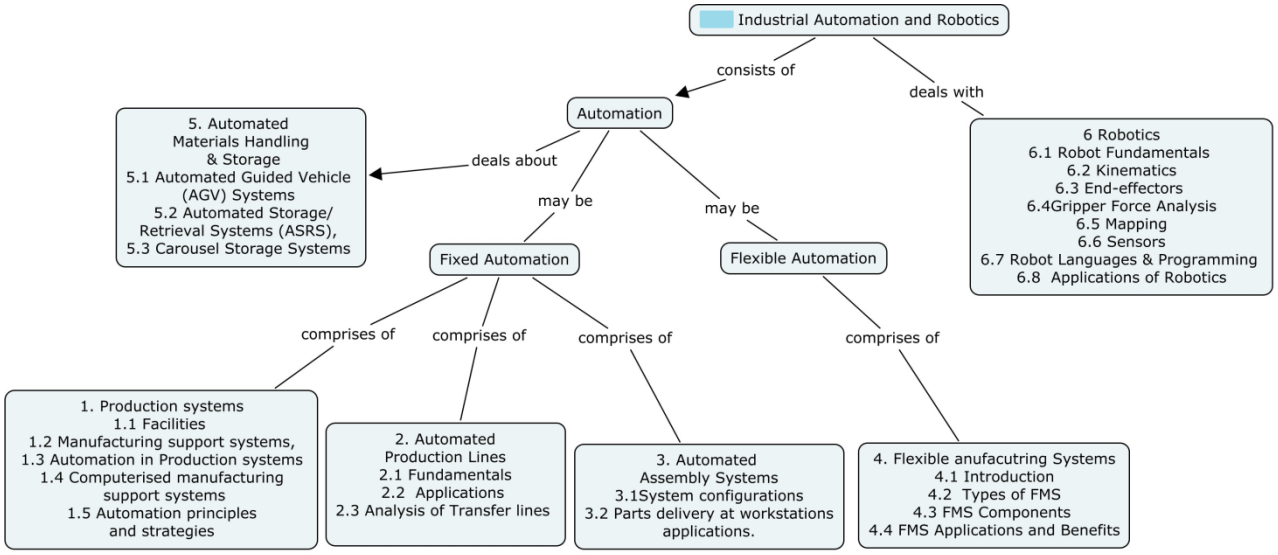
Course Outcome 5 (CO5):

1. A 5 kg rectangular block is gripped in the middle and lifted vertically at a velocity of 1 m/s. If it accelerates to a velocity of 27.5m/s^2 and the coefficient of friction between the gripping pads and the block is 0.48, calculate the minimum force that would prevent the slippage.
2. Discuss the Robot programming languages in brief.
3. Distinguish between the first generation and second generation robot languages.

Course Outcome 6 (CO6):

1. How do external sensors differ from internal sensors?
2. Select the suitable sensor for the following applications (a) to indicate distance (b) to indicate the presence (c) Inspection.
3. Suggest the several possible layouts of the segmented in-line configuration of an automated production line.

Concept Map



Syllabus

Production systems: Facilities – Manual work systems, worker-machine systems and automated systems. Manufacturing support systems, Automation in Production systems – Automated Manufacturing systems, Computerized manufacturing support systems, Manual labour in Production systems, Automation principles and strategies.

Automated Production Lines: Fundamentals- System configurations, work part transfer mechanisms, Storage buffers, and Control of the production line. Applications – Machining systems and System Design Considerations. Analysis of Transfer lines – Transfer lines with No internal parts storage, Transfer lines with internal storage buffers.

Automated Assembly Systems: System configurations, Parts delivery at workstations, and applications, quantitative analysis of assembly systems-Parts Delivery System at Workstations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation

Automated Material Transport & Storage systems: Automated Guided Vehicle (AGV) Systems, Types and applications, Vehicle Guidance Technology, Vehicle Management and Vehicle safety. Automated Storage/Retrieval Systems (ASRS) and Carousel Storage Systems.

Robotics: Definition, Robot fundamentals, anatomy, specifications, Robot arm, Robot end effectors – Classification, Types of grippers, Drive systems for grippers, Gripper force analysis. Sensors, types of sensors, actuators, applications of robots. Introduction to swarm robot, Industry 4.0.

Reference Books

1. Mikell P. Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, Pearson Publisher, Fourth Edition, 2016.
2. P. Radhakrishnan, S. Subramanyan and V. Raju, ‘CAD/CAM/CIM’, New Age International (P) Ltd., New Delhi, 2009.
3. S.R.Deb and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, Second Edition, New Delhi 2010.
4. Popov and E.I. Yurevih, “Robotics", MIR Publications, Moscow, 1987.
5. Yoram Koren, "Robotics for Engineers", Tata McGraw Hill - International Edition, 1989.

Course contents and Lecture Schedule

Module Number	Topics	No. of Lectures
1	**Production systems**	
1.1	Facilities – Manual work systems	1
1.2	Worker-machine systems and Automated systems, Manufacturing support systems	1
1.3	Automation in Production systems – Automated Manufacturing system	1
1.4	Computerized manufacturing support systems, Manual labour in Production systems	1
1.5	Automation principles and strategies.	1
2	**Automated Production Lines**	
2.1	Fundamentals- System configurations	1
	Work part transfer mechanisms, Storage buffers, and Control of the production line.	1
2.2	Applications – Machining systems and System Design Considerations.	1
2.3	Analysis of Transfer lines – Transfer lines with No internal parts storage	2
2.4	Transfer lines with internal storage buffers.	2
3	**Automated Assembly Systems**	
3.1	System configurations	1
3.2	Parts delivery at workstations, and applications.	1
3.3	Quantitative analysis of assembly systems-Parts Delivery System at Workstations	1
3.4	Multi-Station Assembly Machines	2
3.5	Single Station Assembly Machines	2
3.6	Partial Automation	2
4	**Automated Material Transport systems**	
4.1	Types of vehicles, Automated Guided Vehicle (AGV) applications, Vehicle Guidance Technology, Vehicle Management and Vehicle safety.	2
4.2	Automated Storage systems: Automated Storage/Retrieval Systems (ASRS)	1
4.3	Carousel Storage Systems	2
5	**Robotics**	
5.1	Robot Fundamentals - Definition - Anatomy – Specifications	2
5.2	Robot arm , Robot end effectors – Classification, Types of grippers, Drive systems for grippers	2
5.3	Gripper Force Analysis	2
5.4	Sensors, types of sensors, actuators	2
5.5	Applications of robots.	2
5.6	Introduction to swarm robot, Industry 4.0.	1
	Total	37

Course Designers

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18IEPK0 OPERATIONS MANAGEMENT Category L T P Credit

(Common to 18MGPN0) PE 3 0 0 3

Preamble

Operation Management (OM) is the process of managing people and resources in order to create a product or a service. OM has been the key element in the improvement in the productivity around the world. The major concerns of operations management study are Strategies, Process analysis, Demand forecasting, Aggregate Sales and Operations Planning, Inventory Management, Materials Requirement Planning (MRP), Operations Scheduling, Just – In-Time and Lean Systems. The goal is to create a competitive advantage for industrial and production engineering students of post graduate level by conveying a set of skills and tools that they can apply in their profession.

Prerequisite

- Nil

Course Outcomes

On successful completion of the course, students will be able

CO.No	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO 1.	Explain Aggregate Production Planning Strategies and Techniques, Forecasting methods, Inventory Management models and costs, MRP structure, and Concept of JIT and Lean manufacturing.	Understand	80	70
CO 2.	Draw process flow chart and determine process performance and productivity measures.	Apply	70	60
CO3.	Determine, demand forecast, order quantity, and safety stock levels and develop MRP schedules	Apply	70	60
CO 4.	Examine inventory models and lot sizing methods.	Analyse	70	60
CO 5.	Determine optimal sequence and Schedule the jobs in single machine, flow shop and job shop environments.	Apply	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Operation Management.
2. How does mixed strategy differ from pure strategy?
3. Describe the Frame work for operations strategy in manufacturing.
4. Compare and contrast JIT and MRP, stating their main features

Course Outcome 2 (CO2):

1. Consider the construction of a simple 8" X 10" wood picture frame. The picture frame consists of four wood pieces that are cut from the wood molding, four staples to hold the frame together, a piece of glass, a backing board made of cardboard, six points to hold the glass and backing board to the frame, and a clip for hanging the picture frame from the wall.
   - **i)** Construct an assembly chart for the picture frame.
   - ii) Construct a flow process chart for the entire process from receiving materials to final inspection

2. Various financial data for 2010 and 2011 are given. Calculate the total productivity measure and partial measures of labour, capital, and raw materials for this company for both years. What do these measures indicate?

Parameter		Year 2010 in Rs.	Year 2011 in Rs.
Output	Sales	2,00,000	2,20,000
Input	Labour	30,000	40,000
	Raw Materials	35,000	45,000
	Energy	5,000	6,000
	Capital	50,000	50,000
	Other	2,000	3,000

3. Draw the process flow chart for an example product of industrial importance.

Course Outcome 3 (CO3):

1. Historical demand for a product is:

Month	**Demand**
January	12
February	11
March	15
April	12
May	16
June	15

   a. Using weighted moving average with weights of 0.60, 0.30, and 0.10, find the July forecast.

b. Using a simple three-month moving average, find the July forecast.
c. Using single exponential smoothing with a = 0.2 and a June forecast = 13, find the July forecast. Make whatever assumptions you wish.

Using simple linear regression analysis, calculate the regression equation for the preceding demand data.

2. From the following information, formulate an inventory management system. The item is demanded 50 weeks a year.

Item cost Order cost Annual holding cost (%) Annual demand Average demand	$10.00 $25.00 33% of item cost 25,750 515 per week	Standard deviation of weekly demand Lead time Service level	25 per week 1 week 95%

i) State the order quantity and recorder point.
ii) Determine the annual holding and order costs.
iii) How many units per order cycle would you expect to the short?
iv) It a price break of $50 per order was offered for purchase quantities of over 2,000, would you take advantage of it? How much would you save on an annual basis?

3. Product X is made of two units of Y and three of Z. Y is made of one unit of A and two units of B.Z is made of two units of A and four units of C. Lead time for X is one week; Y, two weeks; Z, three weeks; B, one week; and C, three weeks.

i). Draw the bill of materials (product tree structure)

ii). If 200 units of X are needed in week 10, develop a planning schedule showing when each item should be ordered and in what quantity.

Course Outcome 4 (CO4):

1. The annual demand of a product is 48000 units the average lead time is 4 weeks. The standard deviation of demand during average lead time is 75 units per week. The cost of ordering is Rs400 per order. The cost of purchase of the product per unit is Rs.10. The cost of carrying per unit per year is 15% of the purchase price. The maximum delay in lead time is 2 weeks and the probability of the delay is 0.25. Assume service level of 0.95.
   (i) If Q system is followed find the reorder level,
   (ii) If P system is followed find the maximum inventory level.
2. Compare P and Q Inventory models.
3. A company manufacture iron box the MPS of the final assembly is shown below.

Month	1	2	3	4	5	6	7	8
Projected Requirements	-	3500	3000	45000	-	1000	4000	5500

The initial stock on hand is 1150 units. The carrying cost is R2.5 per unit per month and the lead time is one month. The ordering cost per order is Rs.6000. Develop an EOQ solution and compares it with LUC method.

Course Outcome 5 (CO5):

1. Use graphical method to minimize the time needed to process the following jobs on the machines. Shown (i.e. for each machine the job which should be scheduled first). Also, calculate the total time elapsed to complete both jobs.

	Sequence	A	B	C	D	E
Job 1	Time (Hrs)	2	6	5	4	7

	Sequence	C	B	D	A	E
Job 2	Time (Hrs)	6	5	7	4	8

2. Consider the following 3 machines and 5 jobs flow shop problem. Check whether Johnson's rule can be extended to this problem. If so, what is the optimal schedule and corresponding makespan?

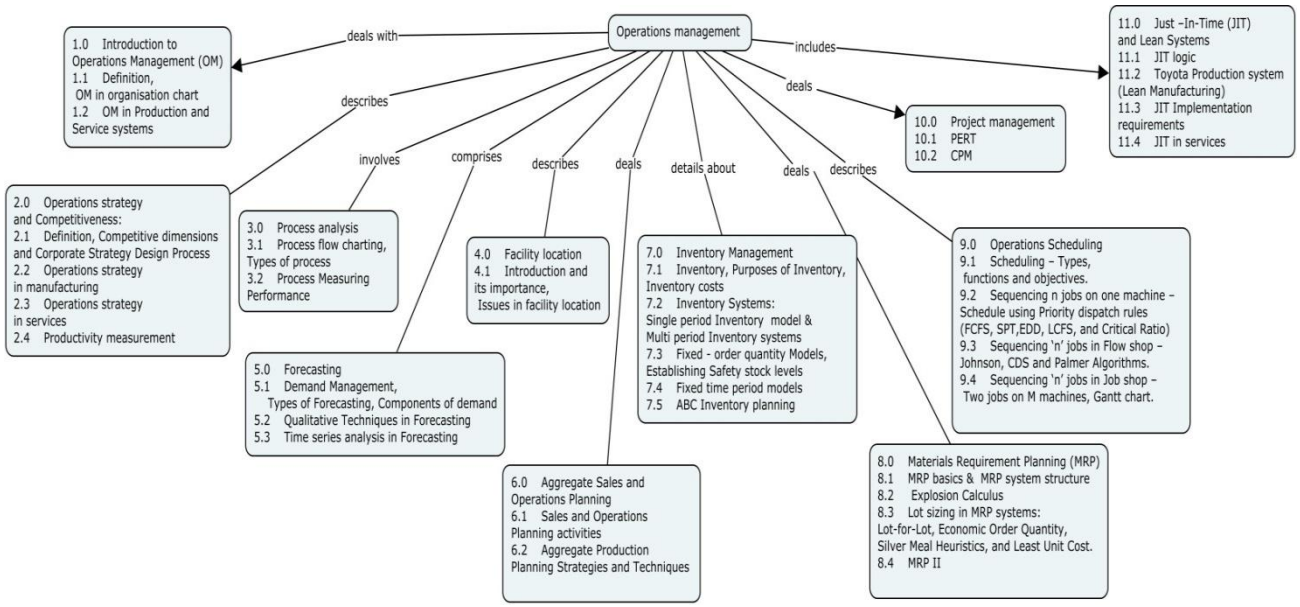
Job	Machine 1	Machine 2	Machine 3
1	11	10	12
2	13	8	20
3	15	6	15
4	12	7	19
5	20	9	7

3. Consider the following single machine scheduling problem with weights.

Job	1	2	3	4	5
Processing time	15	4	5	14	8
Weights	1	2	1	2	3

Determine the sequence which will minimize the weighted mean flow time of the problem.

Concept Map



Syllabus

Introduction to Operations Management (OM): Definition, OM in organisation chart, OM in Production and Service systems. **Operations strategy and Competitiveness:** Definition, Competitive dimensions and Corporate Strategy Design Process, Operations strategy in manufacturing, Operations strategy in services, Productivity measurement.

Process analysis: Process flow charting, types of processes and Process Measuring Performance. **Facility location**- Introduction and its importance, Issues in facility location. **Forecasting:** Demand Management, Types of Forecasting, Components of demand, Qualitative Techniques, and Time series analysis in Forecasting.

Aggregate Sales and Operations Planning: Sales and Operations Planning activities, Aggregate Production Planning Strategies and Techniques. **Inventory Management:** Inventory, Purposes of

Inventory, Inventory costs, Inventory Systems: Single period Inventory model & Multi period Inventory systems. Fixed - order quantity Models, Establishing Safety stock levels, Fixed time period models and ABC Inventory planning.

Materials Requirement Planning (MRP): MRP basics & MRP system structure, Explosion Calculus, Lot sizing in MRP systems: Lot-for-Lot, Economic Order Quantity, Silver Meal Heuristics, and Least Unit Cost. MRP II.

Operations Scheduling: Scheduling – Types, functions and objectives, Sequencing n jobs on one machine – Schedule using Priority dispatch rules (FCFS, SPT,EDD, LCFS, and Critical Ratio). Sequencing 'n' jobs in Flow shop – Johnson, CDS and Palmer Algorithms. Sequencing 'n' jobs in Job shop – Two jobs on M machines, Gantt chart.

Project management - PERT and CPM. **Just –In-Time (JIT) and Lean Systems:** JIT logic, Toyota Production system (Lean Manufacturing), JIT Implementation requirements and JIT in services.

Reference Books

1. Chase, Jacobs, Aquilano, "**Production and Operations Management**", Tenth Edition, Irwin McGraw Hill Companies Inc., 2008.
2. B.Mahadevan, **" Operations Management : Theory and practice"**, Pearson Education India, 2010.
3. Paneer Selvam.R, "**Production and Operations Management**", Prentice-hall of India, 2012.
4. William J.Stevenson, **"Operations Management",** Seventh Edition, McGraw Hill Irwin, 2002.
5. Steven Nahmias, "**Production and Operations Analysis**", Third Edition, Irwin McGraw Hill Companies Inc., 2008.
6. Chary, "**Theory and Problems in Production and Operations Management**", Second reprint, Tata McGraw Hill, 2013
7. Monks, Joseph.G, "**Operations management : theory and problems",** Third Edition, McGraw-Hill series in management, 1987.

Course Contents and Lecture schedule

S.NO	Topics	No. of Lectures
1.0	**Introduction to Operations Management (OM)**	
1.1	Definition, OM in organisation chart	1
1.2	OM in Production and Service systems	1
2.0	**Operations strategy and Competitiveness**	
2.1	Definition, Competitive dimensions and Corporate Strategy Design Process	1
2.2	Operations strategy in manufacturing	1
2.3	Operations strategy in services	1
2.4	Productivity measurement	1
3.0	**Process analysis**	
3.1	Process flow charting, Types of process	2
3.2	Process Measuring Performance	1
4.0	**Facility location**	
4.1	Introduction and its importance, Issues in facility location	1
5.0	**Forecasting**	
5.1	Demand Management, Types of Forecasting, Components of demand	1
5.2	Qualitative Techniques in Forecasting	1
5.3	Time series analysis in Forecasting	1

S.NO	Topics	No. of Lectures
6.0	**Aggregate Sales and Operations Planning**	
6.1	Sales and Operations Planning activities	1
6.2	Aggregate Production Planning Strategies and Techniques	1
7.0	**Inventory Management**	
7.1	Inventory, Purposes of Inventory, Inventory costs	1
7.2	Inventory Systems: Single period Inventory model & Multi period Inventory systems	1
7.3	Fixed - order quantity Models, Establishing Safety stock levels	2
7.4	Fixed time period models	1
7.5	ABC Inventory planning	1
8.0	**Materials Requirement Planning (MRP)**	
8.1	MRP basics & MRP system structure	1
8.2	Explosion Calculus	1
8.3	Lot sizing in MRP systems: Lot-for-Lot, Economic Order Quantity, Silver Meal Heuristics, and Least Unit Cost.	2
8.4	MRP II	1
9.0	**Operations Scheduling**	
9.1	Scheduling – Types, functions and objectives.	1
9.2	Sequencing n jobs on one machine – Schedule using Priority dispatch rules (FCFS, SPT,EDD, LCFS, and Critical Ratio)	1
9.3	Sequencing ‘n’ jobs in Flow shop – Johnson, CDS and Palmer Algorithms.	2
9.4	Sequencing ‘n’ jobs in Job shop – Two jobs on M machines, Gantt chart.	2
10.0	**Project management**	
10.1	PERT	1
10.2	CPM	1
11.0	**Just –In-Time (JIT) and Lean Systems**	
11.1	JIT logic	1
11.2	Toyota Production system (Lean Manufacturing)	1
11.3	JIT Implementation requirements	1
11.4	JIT in services	1
Total		**38**

Course Designers

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18IEPN0	SUPPLY CHAIN MANAGEMENT	Category	L	T	P	Credit
	(Common to 18MGPU0)	PE	3	0	0	3

Preamble

Supply Chain Management (SCM) is the management of a network of interconnected businesses in the ultimate provision of product and service packages required by end customers. Supply chain management spans all movement and storage of raw materials, work-in-process inventory,and finished goods from point of origin to point of consumption. Organizations increasingly find that they must rely on effective Supply Chain, or networks, to compete in the global market and networked economy. Concept of business relationships extends beyond traditional enterprise boundaries and seeks to organize entire business processes throughout a value chain of multiple components. During the past decades, globalization, outsourcing and information technology have enabled to successfully operate solid collaborative supply networks in which each specialized business partner focuses on only a few key strategic activities. This inter-organizational supply network can be acknowledged as a new form of organization.

Prerequisite

Probability and statistics

Course Outcomes

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

CO.No	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO 1.	Explain important issues in the design of the logistics network, inventory management and risk pooling	Understand	80	70
CO 2.	Explain the value of information, Distribution strategies, and strategic alliances	Understand	80	70
CO 3.	Explain the International Supply Chain Management, supplier integration, customer value and Information Technology	Understand	80	70
CO 4.	Calculate the distribution cost, bullwhip effect, order quantity, and safety stock levels	Apply	70	60
CO 5.	Demonstrate case studies about distribution strategies, strategic alliances, and coordinated product design	Apply	70	60
CO 6.	Identify the ways of improving customer value, supplier integration, mass customization and integrating SC and IT.	Apply	70	60

Mapping with Programme Outcomes

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

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

- S- Strong; M-Medium; L-Low

Assessment Pattern

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define SCM.
2. Give the issues important in the design of the logistics network.
3. Explain the key requirements and features of any decision-support system for network design.

Course Outcome 2 (CO2):

1. Explain the three distinct outbound distribution strategies.
2. Describe various types of Retailer-Supplier Partnerships?
3. Explain the factors that are to be considered to determine whether a particular strategic alliance is appropriate or not.

Course Outcome 3 (CO3):

1. Why SC integration is difficult? Explain.
2. What is Electronic Commerce?
3. Explain the requirements for global strategy implementation.

Course Outcome 4 (CO4):

1. Consider a manufacturer shipping a single fully loaded truck form Chennai to Indore. The manufacturer is using a TL carrier whose rate is Rs16.00 per mile per truck load. Calculate the transportation cost for this shipment. The longitude and latitude of Chennai is 13° 04' and 80° 17' and longitude and latitude of Indore is 22º43' and 75º49'.

2. A distribution company is involved in the distribution of TV sets. Whenever the distributor places an order for TV sets, there is a fixed cost of Rs2,00,000/- which is independent of the order size.

Parameter	Average Weekly demand	Safely stock	Reorder point
Value	44.58	86	176

The cost of TV set to the distributor is Rs12,000 and annual holding cost is about 16% of the product cost. Find the weekly inventory holding cost, optimal order quantity and

Order- up-to level.

3. Weekly demand for HP printers at Sam's club store is normally distributed, with a mean of 250 and a standard deviation of 150. The store manager continuously monitors inventory and currently orders 1,000 printers each time the inventory drops to 600 printers. HP currently takes two weeks to fill an order. How much safety inventory does the store carry? What CSI does Sam's club achieve as a result of this policy? What fill rate does the store achieve?

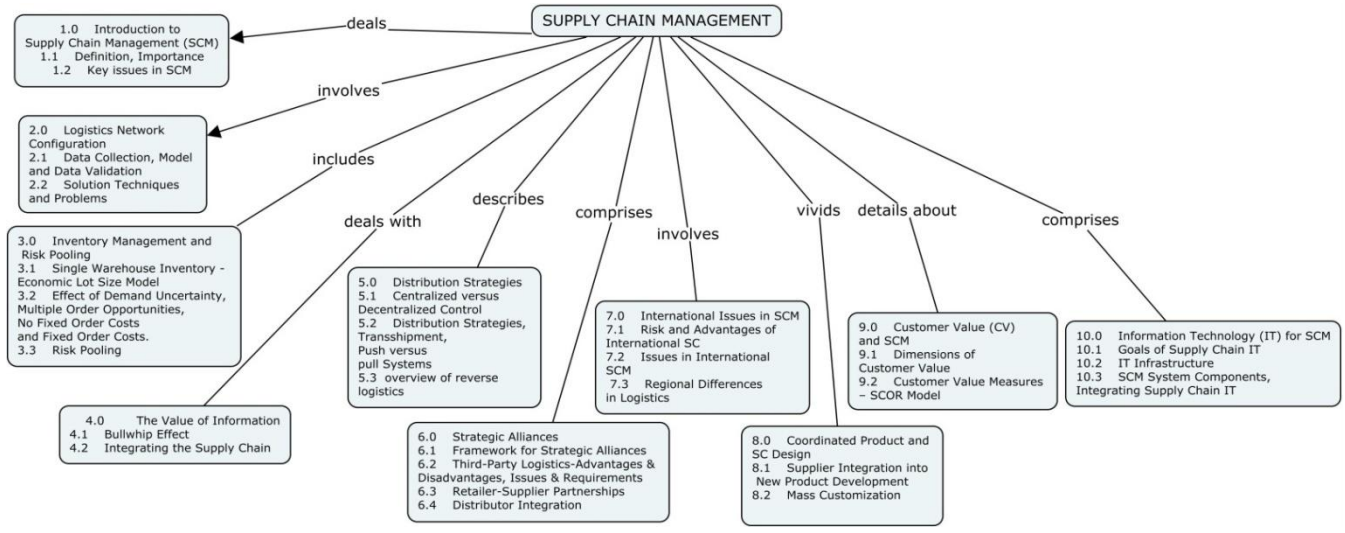
Course Outcome 5 (CO5):

1. Demonstrate the functioning of Amazon's supply chain network.
2. Review the effects of VMI implementation with two cases study examples.
3. Comment the statement "Information is the key enabler of integrating different SC stages with trade-offs.

Course Outcome 6 (CO6):

1. Clarify with example case studies, how information technology is used to enhance customer value in supply chain?
2. Identify and expose a case study for the successful implementation of delayed product differentiation.
3. Comment on the ERP implementation experiences of the coffee producers M/s Starbucks and M/s Green Mountain.

Concept Map



Syllabus

Introduction to Supply Chain Management (SCM): Definition, Importance, Key issues in SCM **Logistics Network Configuration**: Data Collection, Model and Data Validation, Solution Techniques and Problems, **Inventory Management and Risk Pooling:** Single Warehouse Inventory - Economic Lot Size Model, Effect of Demand Uncertainty, Multiple Order Opportunities, No Fixed Order Costs and Fixed Order Costs. Risk Pooling. **The Value of Information**: Bullwhip Effect Integrating the SC. **Distribution Strategies:** Centralized versus Decentralized Control, Distribution Strategies, Transshipment, Push versus pull Systems, overview of Reverse Logistics . **Strategic Alliances**: A Framework for Strategic Alliances, Third-Party Logistics- Advantages & Disadvantages, Issues and Requirements, Retailer-Supplier Partnerships, Distributor Integration. **International Issues in SCM:** Risk and Advantages of International SC, Issues in International SCM, Regional Differences in Logistics. **Coordinated Product and SC Design**: Supplier Integration into New Product Development, Mass Customization. **Customer Value (CV) and SCM**: Dimensions of Customer Value, Customer Value Measures – SCOR Model. **Information Technology (IT) for SCM**: Goals of Supply Chain IT, IT Infrastructure, SCM System Components, Integrating Supply Chain IT.

Reference Books

1. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith, “Designing and Managing the Supply Chain”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
2. A.RaviRavindran, Donald P.Waesing Jr “Supply Chain Engineering: Models and Applications” CRC Press, 2013
3. Chopra S and Meindl P, “Supply Chain Management: Strategy, Planning, and Operation”, Second Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2012.
4. R.P.Mohanty, S.G.Deshmukh, “Supply Chain Management Theories & Practices”, biztantra 2012.
5. Sahay B S, “Supply Chain Management”, Macmillan Company, 2001.
6. David Brunt and David Taylor, “Manufacturing Operations and Supply Chain Management : The Lean Approach”, Vikas Publishing House, New Delhi, 2002.

Course Contents and Lecture schedule

Sl.No	TOPICS	No. of Lectures
1.0	**Introduction to Supply Chain Management (SCM)**	
1.1	Definition, Importance	1

1.2	Key issues in SCM	1
2.0	**Logistics Network Configuration**	
2.1	Data Collection, Model and Data Validation	2
2.2	Solution Techniques and Problems	2
3.0	**Inventory Management and Risk Pooling**	
3.1	Single Warehouse Inventory - Economic Lot Size Model	2
3.2	Effect of Demand Uncertainty, Multiple Order Opportunities, No Fixed Order Costs and Fixed Order Costs.	1
3.3	Risk Pooling	2
4.0	**The Value of Information**	
4.1	Bullwhip Effect	1
4.2	Integrating the Supply Chain	1
5.0	**Distribution Strategies**	
5.1	Centralized versus Decentralized Control	1
5.2	Distribution Strategies, Transshipment, Push versus pull Systems	2
5.3	Overview of Reverse Logistics	1
6.0	**Strategic Alliances**	
6.1	Framework for Strategic Alliances	2
6.2	Third-Party Logistics-Advantages & Disadvantages, Issues & Requirements	1
6.3	Retailer-Supplier Partnerships	2
6.4	Distributor Integration	1
7.0	**International Issues in SCM**	
7.1	Risk and Advantages of International SC	2
7.2	Issues in International SCM	1
7.3	Regional Differences in Logistics	1

8.0	**Coordinated Product and SC Design**	
8.1	Supplier Integration into New Product Development	1
8.2	Mass Customization	2
9.0	**Customer Value (CV) and SCM**	
9.1	Dimensions of Customer Value	2
9.2	Customer Value Measures – SCOR Model	1
10.0	**Information Technology (IT) for SCM**	
10.1	Goals of Supply Chain IT	2
10.2	IT Infrastructure	1
10.3	SCM System Components, Integrating Supply Chain IT	2
	Total	38

Course Designers

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18IE210	QUALITY AND RELIABILITY ENGINEERING	Category	L	T	P	Credit
		PC	3	0	0	3

(Use of Statistical Tables, Distribution Tables – Normal and Poisson, Control Chart Tables and Dodge Romig tables, IS2500 Part I and II are allowed in the Exam Hall)

Preamble

Quality engineering is the management, development, operation and maintenance of manufacturing systems and enterprise architectures with a high quality standard. It is focusing on quality control and quality assurance management through use of physical technology, standards information, and statistical tools.

Reliability engineering is a sub-discipline of systems engineering that emphasizes dependability in the lifecycle management of a product. Dependability, or reliability, describes the ability of a system or component to function under stated conditions for a specified period of time.

Prerequisite

- NIL

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Develop the process control charts – variables, attributes.	Apply	80	70
CO2.	Analyse the process control charts.	Analyze	70	70
CO3.	Explain the concept of Multivariate quality control.	Understand	70	80
CO4.	Develop and comment the Sampling plans – single, double and multiple.	Apply	80	70
CO5.	Compute the system Reliability of different system configuration with redundancy and standby modes	Apply	80	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	10	10
Understand	30	40	20	20
Apply	30	40	50	50
Analyse	20	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Outcome 1 (CO1):

1. An automatic lathe machines a specified spindle with diameter 15.00±0.04mm. Control chart for X bar and R charts are maintained for this process. The sub group size is 5. The values for above are computed for each subgroup. After 20 subgroups ΣX bar = 627.48 & ΣR = 125.0. Compute the values of 3 sigma limits for above charts. Estimate the values of sigma on the assumption that the process is in control. (A1=1.6, A2= 0.58, d2=2.326, D3=0, D4=2.11, B3=0, B4=2.09).
2. In a factory producing spark, plug the number of defectives found in inspection of 20 lots of 100 each, is given below:

Lot No.	No. of defectives	Lot No.	No. of defectives
1	5	11	4
2	10	12	7
3	12	13	8
4	8	14	3
5	6	15	3
6	4	16	4
7	6	17	5
8	3	18	8
9	3	19	6
10	5	20	10

   (a) Construct appropriate control chart and state whether the process is in statistical control.

3. The following table shows the results of successive lots of parts produced by a plastic moulding press. As each lot comes of the line, a random sample of 150 pieces each was inspected and the results are as given below.

Lot No.	1	2	3	4	5	6	7	8	9	10
No. of Defects	4	8	2	4	4	6	10	4	6	8

(i) Compute control limits
(ii) Plot the appropriate chart
(iii) Draw Conclusion

Course Outcome 2 (CO2):

1. Control charts for *X* bar and *R* are maintained on a certain dimension of a manufactured part measured in cm. The subgroup size is 5. The values of *X bar* and *R* are computed for each subgroup. After 25 subgroups ΣX bar = 41.283 and ΣR = 0.339, compute the values of 3σ limits for *X bar* and *R* chart and estimate the value of sigma on the assumption that the process is in statistical control also determine the process capability and Interpret the results.
2. The percent of water absorption is an important characteristic of common building brick. A certain company occasionally measured this characteristic of its product but records were never kept. It was decided to analyze the process with control chart. Twenty-five samples of four bricks each yielded these results.

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13
X	15.01	12.3	7.4	8.7	8.8	11.7	10.2	11.5	11.2	10.2	9.6	7.6	7.6
R	9.1	9.9	9.7	6.7	7.1	9.1	12.1	10.8	13.5	6.9	5.0	8.2	5.4

Sample No.	14	15	16	17	18	19	20	21	22	23	24	25
X	9.8	8.8	8.1	6.3	10.5	9.7	11.7	13.2	12.5	7.5	8.8	8.0
R	17.5	10.5	4.4	4.1	5.7	6.4	4.6	7.2	8.3	6.4	6.9	6.4

Estimate the control limits for X and R chart. If any point lies out of the control limits, estimate the revised control limits and analyse the shift in process mean for both the conditions.

Course Outcome 3 (CO3):

1. Explain about Hotelling T^2 control chart for multivariate analysis.
2. Describe about covariance matrix and its applications.
3. Explain the Difference between dependent and independent variables.

4. Explain the two dependent variables for Multivariate quality control

Course Outcome 4 (CO4):

1. Draw an OC curve for a sampling plan n = 40 and c = 1. From the curve find AQL, Split risk quality and LTPD.
2. Construct the AOQ, AOQL curve for a sampling plan N=4000, n=40, c=2.
3. Compute the probability of acceptance for the following double sampling plan with an incoming fraction defective 0.02

   n_1= 65 c_1 = 1 R_1 = 3

   n_2 = 90 c_2 = 2 R_2 = 3

   Also compute ATI, ASN for N = 750.
4. Write the Step by step procedure to construct OC curve for double sampling plan with an incoming fraction defective 0.02

   n_1= 65 c_1 = 1 R_1 = 3

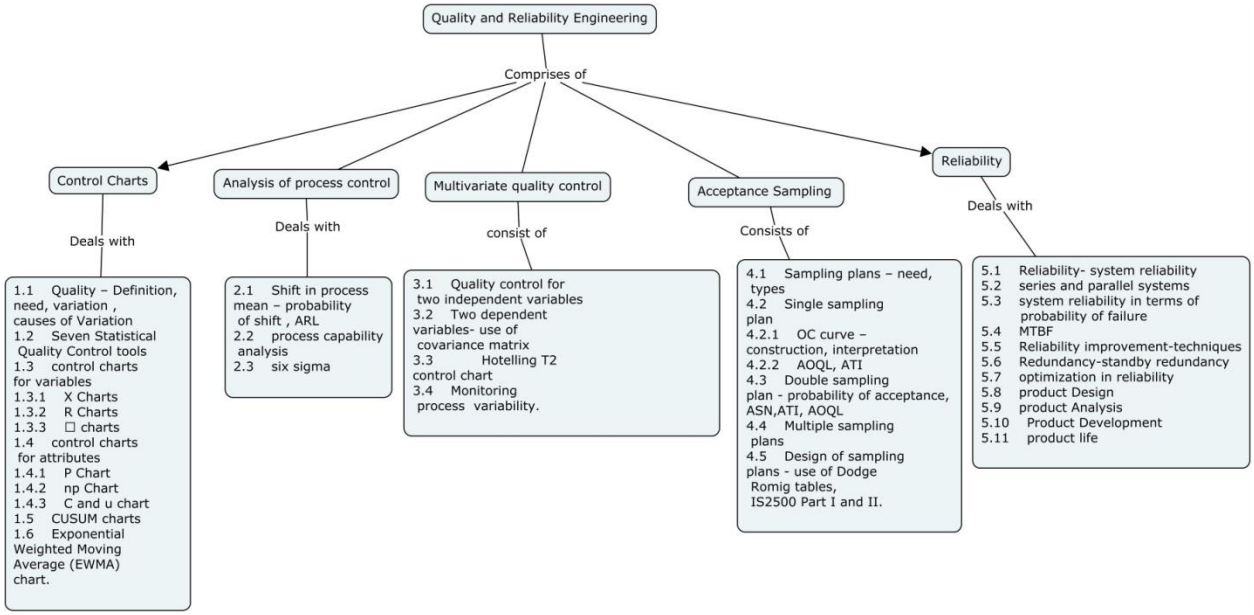
   n_2 = 90 c_2 = 2 R_2 = 3 N = 750.

Course Outcome 5 (CO5):

1. There are 3 modules A, B & C in a system. A is a 2 out of 4 system with component reliability of 0.7. Module B is a 4 out of 7 system with component reliability of 0.65. And module C is of 5/8 system with component reliability of 0.9. Compute the system reliability if A&B is in series and C is in parallel with A&B.
2. An optical sensor has followed the Weibull time to failure distribution with scale parameter of 300 h and shape parameter of 0.6. What is the reliability of the sensor after 500 h of operation?
3. Consider a system with three components A, B and C in parallel. Determine the system reliability for 2000 h of operation, and find the mean time to failure. Assume all the three components have an identical time-to failure distribution that is exponential, with a constant failure rate of 0.0006 per hour. What is the mean time failure of each component?
4. A standby system has a basic unit with four standby components. The time to failure of each component has an exponential distribution with a failure rate of 0.007 per h. For a 400h operation period, find the reliability of the standby system.
5. Propose a system configuration in order to improve its reliability with the known component reliability.

6. A standby system has a basic unit with two standby components. The time to failure of each component has an exponential distribution with a failure rate of 0.004 per h. For a 600h operation period, compute the reliability of the standby system. Develop ways to improve the standby system reliability.

Concept Map



Syllabus

Control charts: Quality – Definition, need- variation – causes- Seven Statistical Quality Control tools – control charts for variables X bar, R and σ charts- control charts for attributes – p, np, c, u chart, CUSUM charts, Exponential Weighted Moving Average (EWMA) chart.

Analysis of process control: Shift in process mean – probability of shift, ARL, process capability analysis, six sigma.

Multivariate quality control: Quality control for two independent variables, two dependent variables- use of covariance matrix – Hotelling T^2 control chart – Monitoring process variability.

Acceptance sampling: Sampling plans – need, types – single sampling plan – OC curve – construction, interpretation, AOQL, ATI- double sampling plan – probability of acceptance, ASN,ATI, AOQL- multiple sampling plans **–** design of sampling plans – use of Dodge Romig tables, IS2500 Part I and II.

Reliability: Reliability- system reliability-series and parallel systems-system reliability in terms of probability of failure-MTBF- Reliability improvement-techniques-Redundancy-standby redundancy optimization in reliability - product Design-product Analysis-Product Development product life.

Reference Books/ Learning Resources

1. Dougles C. Montgomery, **"Introduction to Statistical Quality Control"**, John Wiley and Sons, Inc, Seventh Edition, 2012.
2. Amitava Mitra, **"Fundamentals of Quality Control and Improvement"**, Wily USA, Fourth Edition, 2016.
3. Grant, Eugene .L, **"Statistical Quality Control"**, McGraw-Hill, Tenth reprint, 2008
4. Monohar Mahajan, **"Statistical Quality Control**", Dhanpat Rai and Co (P) Ltd, Third Edition, 2010.
5. NPTEL Video Lectures – Industrial Engineering, Prof.H.S.Shan, Prof.Pradeep Kumar, Prof. P. K. Jain, IIT-ROORKEE. URL: http://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/INDUSTRIAL-ENGINERRING/
6. Charles E. Ebeling, **"An Introduction to Reliability and Maintainability Engineering",** Tata Mc-graw hill publication, eighth edition 2007.
7. Alessandro Birolini, **Reliability Engineering: Theory and Practice, Springer,** Eighth Edition, 2017.
8. Connor, P.D.T.O., **"Practical Reliability Engineering** ", John Wiley, 2012.

Course Contents and Lecture Schedule

Sl.No.	Topics	No. Of Periods
	Control charts	
1.1	Quality – Definition, need, variation , causes of Variation	1
1.2	Seven Statistical Quality Control tools	1
1.3	control charts for variables	
1.3.1	X Charts	1
1.3.2	R Charts	
1.3.3	σ charts	1
1.4	control charts for attributes	

1.4.1	P Chart	1
1.4.2	np Chart	1
1.4.3	C and u chart	1
1.5	CUSUM charts	
1.6	Exponential Weighted Moving Average (EWMA) chart.	1
2.	**Analysis of process control**	
2.1	Shift in process mean – probability of shift , ARL	2
2.2	process capability analysis	2
2.3	six sigma	
3	**Multivariate quality control**	
3.1	Quality control for two independent variables	1
3.2	Two dependent variables- use of covariance matrix	1
3.3	Hotelling T^2 control chart	1
3.4	Monitoring process variability.	1
4	**Acceptance sampling**	
4.1	Sampling plans – need, types	1
4.2	Single sampling plan	1
4.2.1	OC curve – construction, interpretation	2
4.2.2	AOQL, ATI	1
4.3	Double sampling plan - probability of acceptance, ASN,ATI, AOQL	2
4.4	Multiple sampling plans	1
4.5	Design of sampling plans - use of Dodge Romig tables, IS2500 Part I and II.	1
5	**Reliability**	
5.1	Reliability- system reliability	1
5.2	series and parallel systems	
5.3	system reliability in terms of probability of failure	2
5.4	MTBF	2
5.5	Reliability improvement-techniques	1
5.6	Redundancy-standby redundancy	2

5.7	optimization in reliability	1
5.8	product Design	1
5.9	product Analysis	
5.10	Product Development	1
5.11	product life	
	Total	**36**

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		Category	L	T	P	Credit
18IE260	**SIMULATION AND MODELING**	PC	2	0	2	3

Preamble

System Simulation is the imitation of some real thing, state of affairs, or process. The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system. Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training. Simulation is also used for scientific modeling of natural systems or human systems in order to gain insight into their functioning. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. **Modeling** is the process of creating an abstract model to simulate the behavior and response of a wide range of systems and prototypes.

Prerequisite

- Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Explain the concepts, types and applications of simulation and modelling.	Understand	80	70
CO2.	Select a suitable simulation model for the given industrial application.	Apply	80	70
CO3.	Generate and test random numbers.	Apply	80	70
CO4.	Verify and validate the model for the given input data.	Analyze	70	60
CO5.	Interpret the output of the simulation model	Analyze	70	60
CO6.	Evaluate the models using simulation software. **(continuous Assessment only)**	Analyze	90	80

Mapping with Programme Outcomes

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

Assessment Pattern

Theory (70 marks)				Practical (30 marks)		
Bloom's	Continuous	Termi		Valuation category	Continuou	Continuous

Category	Assessment Tests (20)		nal Examination (50)			s Assessment 1(10)	Assessment Test 2 (20)
	1	2					
Remember	10	10	10		Classwork/Exercise	90	90
Understand	30	30	30		Record / Viva-voce	10	10
Apply	60	60	60				
Analyse	--	--	--				
Evaluate	--	--	--				
Create	--	--	--				

Theory cum Practical Courses:

- There will be three tests: the first two tests (Maximum 50 marks for each test) will be from theory component and the third test (Maximum 50 Marks) will be for practical component.
- The sum of marks of first two tests shall be reduced to 20 Marks and the third test mark shall be reduced to 20 marks.
- Average mark awarded for viva – voce, conduct of experiments, observation & results, record work in regular class works shall be reduced to 10 marks.
- The sum of these 50 Marks would be rounded to the nearest integer.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define simulation.
2. Define modelling.
3. Describe the different type of system.
4. Explain the advantage and limitations of the simulation.

Course Outcome 2 (CO2):

1. List the type of simulation.
2. Describe the factors that are to be considered in selecting a simulation type.
3. A new bus route is to be added to a city, and the traffic manager is to determine how many extra buses will be needed. What are the three key attributes of the passengers and buses that he should consider? If the company manager wants to asses the effect of the new route on the transit system as a whole, how would you suggest he aggregate the features of the new line to form part of a total system model? Would you suggest a continuous or discrete model?
4. Explain the properties of linear models.

Course Outcome 3 (CO3):

1. Develop a random variate generator.
2. Suppose that the five numbers 0.44, 0.81, 0.14, 0.05, 0.93 were generated, and it is desired to perform a test for uniformity by using the Kolrnogorov-Srnirnov test with the level of significance . α= 0.05. Examine the uniformity.
3. The following data are randomly generated from a gamma Distribution

7.036	5.224	3.917	6.513
4.599	7.563	7.172	5.132
5.259	2.759	4.278	2.696
6.212	2.407	1.857	5.002
4.612	2.003	6.908	3.326

Determine the maximum likelihood estimators of the gamma distribution?

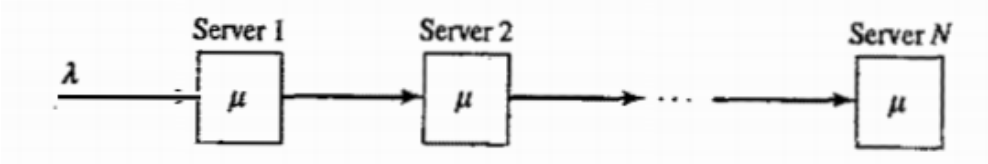
Course Outcome 4 (CO4):

1. Explain the importance of input data analysis.
2. The following data represent the time to perform transactions in a bank, measured in minutes.
   0.74, 1.28, 1.46, 2.36, 0.35, 0.78, 0.91, 4.44, 0.14, 3.08, 3.24, 1.10, 1.59, 1.47, 1.17, 1.27, 9.12, 11.5, 2.42, 1.77. Develop an input model for this data.
3. In a college library, collect the following information at the books return counter: arrival of students for returning books service time taken by the counter clerk . Consolidate the data collected and verify whether it follows any standard distribution
4. The duration of calls in minutes over a telephone line is 2.058 6.407 0.565 0.641 5.989 0.435 0.278 3.447 ll.461 1.658 2.913 2.689 4.747 2.587. Develop an input model for the call duration data.

Course Outcome 5 (CO5):

1. Consider some number, say N, of M/M/1 queues in series. The M/M/1 queue, has Poisson arrivals at some rate customers per hour, exponentially distributed service times with mean 1/ p, and a single server. By M/M/1 queues in series, it is meant that, upon completion of service at a given

server, a customer joins a waiting line for the next server. The system can be shown as follows:



All service times are exponentially distributed with mean 1/p, and the capacity of each waiting line is

assumed to be unlimited. Assume that 8 customers per hour and 1/p = 0.1 hour. The measure of

performance is response time, which is defined to be the total time a customer is in the system.

(a) By making appropriate simulation runs, compare the initialization bias for N = I (i.e., one M/M/1

queue) to N= 2 (i.e., two M/M/1 queues in series). Start each system with all servers idle and no

customers present. The purpose of the simulation is to estimate mean response time.

(b) analyse the initialization bias as a function of N, for N = I, 2, 3, 4, and 5.

(c) Draw some general con clusions concerning initialization bias for "large" queueing systems when at

time 0 the system is assumed to be empty and idle.

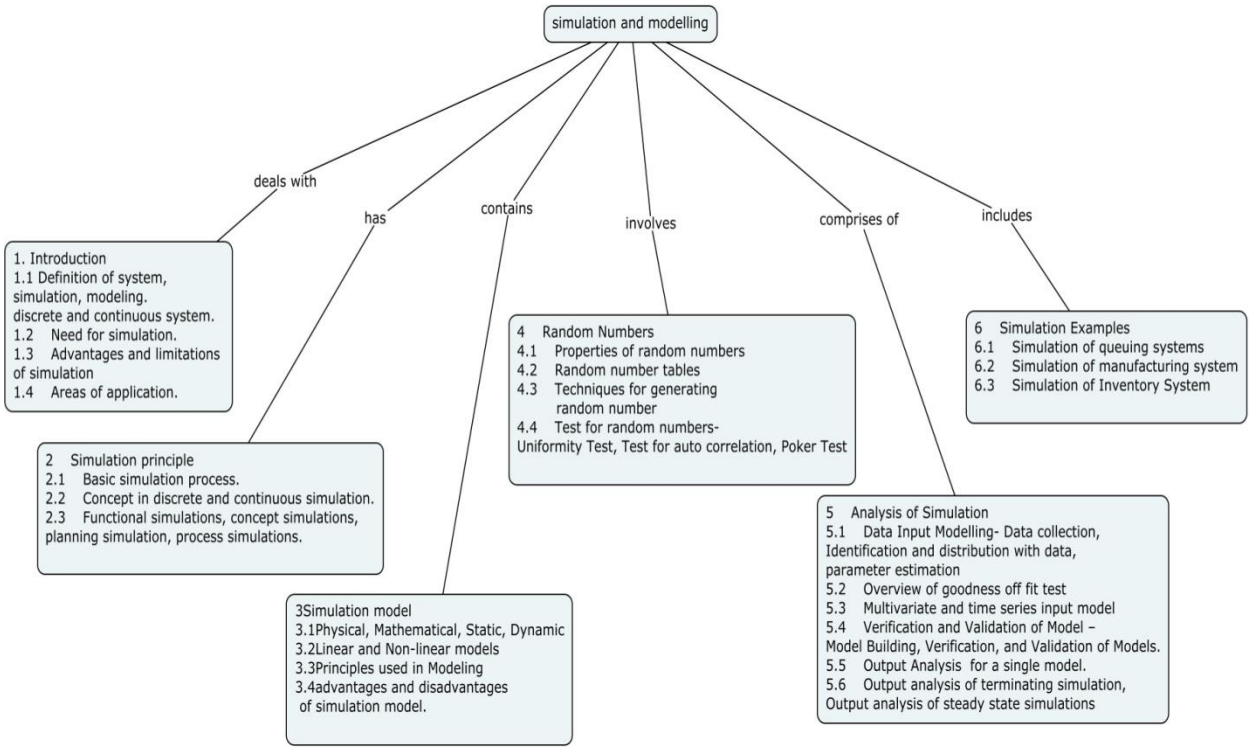
2. In a queuing simulation with 20 replications, 90% confidence interval for average queue length is found to be in the range 1.72-2.41. Analyse the probability that the average queue length is less than 2.75.

3. The average waiting data from 10 replication of a queuing system are

Replication	**Average Waiting Time**
1	1.77
2	2.50
3	1.87
4	3.22
5	3.00
6	2.11
7	3.12
8	3.49
9	2.39
10	3.49

Determine 90% confidence interval for the average waiting time.

Concept Map



Syllabus

Introduction- Concept of system, simulation, modeling. Types of system - discrete and continuous system. Need for simulation. Advantages and Limitations of simulation, Areas of application.Basic simulation process. concept in discrete and continuous simulation. Simulation types- Total enterprise simulations, functional simulations, concept simulations, planning Simulation, process simulations.

Simulation model – Physical, Mathematical, Static, Dynamic, Linear and Non-linear models. Principles used in Modeling.

Random Numbers - Properties of random numbers, random number tables, techniques for generating random number, Test for random numbers- Frequency test, uniformity test, test for auto correlation, Poker Test.

Simulation Examples- Simulation of queuing systems, Simulation of manufacturing system and Simulation of Inventory System.

Analysis of Simulation Data- Data Input Modelling- Data collection, Identification and distribution with data, Random variate generation, parameter estimation. overview of goodness-of-fit test. multivariate and time series input model. Verification and validation of model – Model building, verification, and validation of models.

Output analysis for a Single Model- types, stochastic nature of output data, measures of performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.

Reference Book

1. Jerry Banks, John S.Carson, Barry L.Nelson, David M. Nicol P.Shahabudeen

" **Discrete – Event System Simulation**" Pearson- Fifth Edition, 2014

2. Geoffrey Gordon, "**System Simulation** " Prentice Hall of India, New Delhi, 2003
3. Averill M Law, "**Simulation Modeling and Analysis**" Tata McGraw-Hill Publishing company Limited, New Delhi, Fourth edition,2008.
4. Narsingh Deo, "**System Simulation with Digital Computer**", Prentice Hall of India, New Delhi, 2004.
5. Training workbook for discrete even simulation packages.

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
1	**Introduction**	
1.1	Concept of system, simulation, modeling.	1
1.2	Types of system - discrete and continuous system.	1
1.3	Need for simulation. Advantages and Limitations of simulation, Areas of application.	1
1.4	Basic simulation process. concept in discrete and continuous simulation.	1
1.5	Simulation types- Total enterprise simulations, functional simulations, concept simulations, planning Simulation, process simulations.	1
2	**Simulation model**	
2.1	Physical, Mathematical	1
2.2	Static, Dynamic, Linear and Non-linear models	1
2.3	Principles used in Modeling.	1
3	**Random Numbers**	
3.1	Properties of random numbers	1
3.2	Random number tables	1
3.3	Techniques for generating random number	1
3.4	Test for random numbers- Uniformity Test	1
3.5	Test for auto correlation	1
3.6	Poker Test	1
4	**Simulation Examples**	
4.1	Simulation of queuing systems	1
4.2	Simulation of manufacturing system	1
4.3	Simulation of Inventory System	1
5	**Analysis of Simulation Data**	
5.1	Data Input Modelling- Data collection, Identification and distribution with data, Random variate generation, parameter estimation	1
5.2	Overview of goodness-of- fit test	1
5.3	Multivariate and time series input model	1
5.4	Verification and Validation of Model – Model Building, Verification, and Validation of Models.	1

Module Number	Topic	No. of Lectures
6	**Output analysis for a Single Model**	
6.1	Types, stochastic nature of output data	1
6.2	Measures of performance and their estimation	1
6.3	Output analysis of terminating simulation	1
6.4	Output analysis of steady state simulations.	2
	Total	**26**

Practical Component:

List of Exercises (Discrete event simulation software)
Development of a simulation model for manufacturing / assembly system
Simulation analysis of capacity balancing of manufacturing / assembly system
Capacity increment analysis of manufacturing / assembly system by insertion of a new automated machine.
Discrete event Simulation analysis of a Paint shop of manufacturing / assembly system
Simulation analysis of allocation of resources in a show room based on labour cost.
Development of simulation model for a given shop floor environment by using simulation package.

Course Designers

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18IE270	ANALYTICS LABORATORY	Category	L	T	P	Credit
		PC	0	0	4	2

Preamble

This lab provides the students to explore about various analytics techniques with the intent of performing several functionalities and operations related to Business analytics.

Course Outcomes

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

Course Outcomes		Bloom's Level	Expected Proficiency	Expected level of attainment (%)
CO1:	Apply Data modelling tools to perform Predictive, and Descriptive Analytics for any Real time dataset.	Apply	70	85
CO2:	Analyse the data patterns using data visualization tools for the given application.	Analyse	70	85
CO3:	Develop simple business analytics applications by incorporating different algorithmic techniques in analytics.	Analyse	70	85

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	**L**	**L**			**L**				**L**	**L**	
CO2.	**M**	**L**	**L**		**S**			**M**	**M**	**M**	
CO3.	**S**	**M**	**M**	**L**	**S**	**L**		**L**	**M**	**M**	

S- Strong; M-Medium; L-Low

Lab Contents and Schedule

Ex.No	Experiment	No. of Lecture hours
1.	Study of tools in data analytics such as R Studio, and Python Programming.	2
2.	Perform data pre-processing for the given dataset by performing data cleaning, data transformation and replacing the missing values.	2
3.	Implementation of Data clustering using classical partitioning methods for the given dataset.	2
4.	Implementation of Descriptive analytics using Association rule mining, for the given data.	2

Ex.No	Experiment	No. of Lecture hours
5.	Implementation of Descriptive analytics using FP Growth for the given data.	2
6.	Implementation of Predictive analytics using linear regression for the given dataset.	2
7.	Implementation of Predictive analytics using Decision trees, with Multi-class classification for the given dataset.	2
8.	Perform data visualization with the aim to implement data Relationship using Scatter plot and Bubble chart.	2
9.	Perform data visualization with the aim to implement data distribution using 3D Area chart, Scatter chart, line histogram, and column histogram.	2
10.	Perform data visualization with the aim to implement data composition using Pie chart, Stacked column chart, Stacked area chart, and Waterfall chart for the given data.	2
11.	Perform data visualisation with the aim to implement data comparision using bar chart, column chart, line chart, and circular area chart.	2
12.	A Study on Machine learning techniques for prediction using R/Python/ for Business Analytics.	4
Total Sessions		**26**

Course Designers:

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18IEPB0 COST AND FINANCIAL MANAGEMENT

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

A cost accounting system is a framework used by firms to estimate the cost, assessing cost of production, profitability analysis of the products, inventory valuation, cost control and cost reduction. It is an internal reporting system for the management for decision making. Financial management focuses on effective planning, Investing and managing of funds of an organization. This subject enables the reader to take financial and costing decisions by using various tools and techniques.

Prerequisite

Nil

Course outcomes

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

CO.No.	Course Outcome	Blooms Level	Expected proficiency	Expected attainment level
CO1	prepare the cost at various stages of production and sales, and select appropriate methods of material issues	Apply	70	60
CO2	Perform activity based costing systems in business applications.	Apply	70	60
CO3	Prepare different types of budgets for business activities	Apply	70	60
CO4	Analyse and interpret the financial statements	Analyse	70	60
CO5	Compute working capital requirement, Evaluate long term investment decisions.	Apply	70	60
CO6	Select appropriate sources of finance, Evaluate appropriate capital structure and dividend policy of an organization	Apply	70	60

Mapping with Programme Outcomes

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

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3	End-semester examination
1	Remember	10	10	10	10
2	Understand	30	30	20	20
3	Apply	60	60	50	50

	Bloom's Category	Test 1	Test 2	Test 3	End-semester examination
4	Analyze	0	10	20	20
5	Evaluation	0	0	0	0
6	Create	0	0	0	0

Course Outcomes (COs)

Course outcome 1 (CO1):

1. Define Cost sheet.
2. List the applications of cost sheet.
3. ABC Ltd., a manufacturing company, incurred the following expenses during a certain period. You are required to prepare a statement showing the subdivision of total cost.

	Rs.		Rs.
Materials used on jobs	1,20,540	Depreciation of plant	3,800
Wages traceable to jobs	86,650	Depreciation of delivery vans	1,600
Wages paid to men for maintenance work		Insurance on finished goods	2,500
		Lubrication oil	250
Salaries of sales men	1,26,00	Bad debts	300
Directors' fees	15,100	Commission to salesmen	2,850
Carriage inwards on raw materials	10,000	Cost of idle time in factory	510
		Auditors fees	3,800
Carriage outwards	860	Dividends paid	6,800
Factory rent and rates	2,800	Lighting of showroom	1,500
Works salaries	8,300	Office salaries and expenses	7,000
Hire of crane for job no, 132	20,400	Income tax	8,600
Consumable stores	1,300		

4. From the following particulars prepare a cost sheet showing the total cost per tone for the period ended 31st December 2017

	Rs		**Rs**
Raw material	33,000	Director's fees (office)	2,000
Productive wages	35,000	Factory cleaning	500
Direct expenses	3,000	Sundry office expenses	200
Unproductive wages	10,500	Estimating	800
Factory rent and terms	7,500	Factory stationery	750
Factory lighting	2,200	Office stationery	900
Factory heating	1,500	Factory insurance	1,100
Motive power	4,400	Office insurance	500
Haulage	3,000	Legal expenses	400
Director's fees (works)	1,000	Rent of warehouse	300
Depreciation of		Unkeeping of delivery vans	700
- plant and machinery	2,000	Bank charges	50
- office building	1,000	Commission on sales	1,500
- delivery vans	200	Loose tools written off	600
Bad debts	100	Rent and taxes (office)	500
Advertising	300	Water supply	1,200
Sales department	1,500		

salaries			

The total output for the period has been 10,000 tones.

Course Outcome 2 (CO2):

1. List the advantages of activity based costing.
2. A furniture manufacturing company manufactures two types of chairs. Executive chair and chairman chair. There are two direct costs and three indirect cost pools representing three activity areas at the plant:

Manufacturing activity area	Budgeted costs Rs.	Cost drivers	Volume of cost driver
Material handling	200000	Parts	800000
Cutting	2160000	Parts	864000
Assembly	2000000	Direct labour hrs	80000

Additional information:

Type of Chair	Units Produced	Direct materials	No. of Parts	Direct labour hrs.
Executive	5000	Rs. 600000	100000	7500
Chairman	100	Rs. 25000	3500	500

Direct labour rate is Rs.20/- per hr. Compute selling price per unit under ABC with 20% profit on sales for the above two products.

3. Differentiate activity based costing and traditional based costing.

Course Outcome 3 (CO3):

1. Define budget and budgeting.
2. Describe the advantages of budgetary control.
3. From the following income and expenditure forecast, prepare a cash budget for the months April, May, June. (figures given in Rs.). Estimated cash balance on 1st April Rs. 25000/-

Month	Sales	Purchases	Manu.exp	Admn. Exp
Jan	600000	420000	25000	35000
Feb	620000	440000	25000	37000
Mar	650000	450000	26000	40000
Apr	600000	400000	27000	36000
May	610000	400000	26000	38000
Jun	640000	430000	27000	40000

Additional Information:

a) Plant was purchased in January for Rs.200000. 15% payable as down payment and the remaining payable in ten equal installment from the next month.
b) Dividend due to be paid in April Rs.5000/-, to be received in June Rs.4000/-
c) Advance tax of 3000 is payable in June.
d) Credit allowed to debtors 20% cash sales, remaining in three equal installments starting from next month and by suppliers 2 months.
e) Lag in payment of manufacturing expenses ½ month and administrative expenses ¼ month.
f) Income from investment to be received in April Rs.10000/-.

Commission on purchase of 1.5% and 2% on sales payable in the next month, after two months respectively.

Course Outcome 4 (CO4):

1. Describe the importance of financial statement analysis.

2. From the following statement of Profit & Loss siva Ltd, prepare Comparative Statement of Profit and Loss for the year ended 31-03-2017 and 31-03-2018.

Particulars	31-03-2017	31-03-2018
I)Revenue from Operation	20,00,000	30,00,000
II)Other Incomes	4,00,000	4,50,000
III)Total Revenue (I+II)	24,00,000	34,50,000
IV)Expenses:		
Cost of Raw materials consumed	6,00,000	8,00,000
Purchase of Stock in trade	2,00,000	4,00,000
Employees benefits expenses	1,00,000	1,20,000
Finance cost	80,000	1,00,000
Depreciation	50,000	60,000
Total Expenses:-	10,30,000	14,80,000
V) Profit before Tax(III-IV)	13,70,000	19,70,000
VI) (-) Taxes	40,000	50,000
VII) Profit after Tax	13,30,000	19,20,000

3. With an example prepare common size statement and comment on it.

Course Outcome 5 (CO5):

1.Evaluate and critically analyse the various methods of appraising the capital budgeting decisions?

2.From the following information calculate (i) pay back period (ii)Net present value and profitability index @10% (iii)Internal rate of return and suggest which project can be selected?

Particulars	**Project x**	**Project y**
Initial investment	Rs.20,000	Rs.30,000
Estimated life	5years	5 years
Scrap value	Rs.1000	Rs.2000

Estimated profit before tax and after depreciation (cash flows)is as follows;

Year	1	2	3	4	5
Project "x" (Rs.)	5000	10000	10000	3000	2000
Project "y" (Rs.)	20,000	10,000	5,000	3,000	2,000

3. What are all the factors that would influence working capital requirements of an organization?

4. From the following information estimate working capital requirement.

a. Estimated output 96,000 units per year.

b. Selling price per unit Rs.50/-

c. Estimated cost to selling price.

a) Materials 40% b) Labour 35% C) Overheads 15%

d. Raw materials are expected to remain in stores for an average period of 3 months before issue to production.

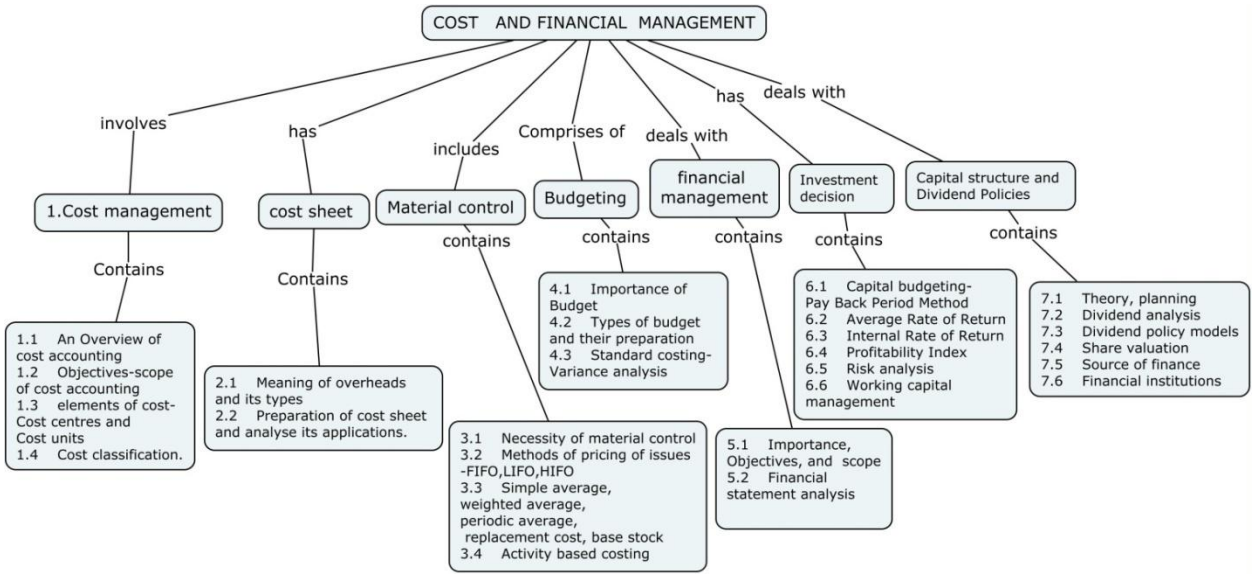
e. Materials will be in process for one month.

f. Finished goods to remain in stock for one and half months (after production till it reaches the customer)
g. Credit allowed to customers 2 months (25% sold for cash)
h. Credit allowed by suppliers 2 months.
i. Cash balance to be maintained Rs.10,000/-
j. Advances paid-Rs.25,000.
k. Delay in payment of wages Rs.5,000
l. Allow 10% for contingencies.

Course Outcome 6 (CO6):

1. What are all the functions of finance?
2. List out some of the sources of long term finance
3. Evaluate the various medium-term and long-term sources of financing.
4. The management of Samata Company, subscribing to the net operating income approach, believes that its cost of debt and overall cost of capital will remain at 8 per cent and 12 per cent, respectively. If the equity shareholders of the firm demand a return of 20 per cent, what should be the proportions of debt and equity in the firm's capital structure? Assume that there are no taxes.

Concept Map



Syllabus

Cost management: An Overview of cost accounting-Objectives-scope of cost accounting-elements of cost- Cost centres and Cost units, cost classification. Preparation of cost sheet and its applications.

Material control: Methods of pricing of issues-FIFO,LIFO,HIFO, Simple average, weighted average, periodic average, replacement cost, base stock – Activity based costing

Cost control: importance of Budget – types of budget and their preparation. **-** Variance analysis.

Financial management: Importance, Objectives, and scope, financial statement analysis

investment decision: Capital budgeting- Pay Back Period Method, Average Rate of Return, Internal Rate of Return, Profitability Index-,Risk analysis- Working capital management**.**

Financing decision: capital structure theory, various approaches and planning. Source of finance and financial institutions.

Dividend policy :Dividend policy models, dividend analysis, share valuation.

Reference Books

1. Don R. Hansen and Maryanne M. Mowen "Cost Management: Accounting and Control, Fifth Edition" Thomson, 2006.
2. Michael C . Ehrhardt and Eugene F . Brigham, "Financial Management: Theory and Practice -thirteenth edition" South-Western cengage learning, 2011
3. Prasanna Chandra, "Fundamentals of Financial Management", Tata McGraw Hill, 2008
4. KY. Khan and P.K. Jain, " Financial Management", Tata McGraw Hill, 2007
5. Pandey, "Financial Management", Vikas Publishing House Pvt. Ltd., 2007
6. PS.Boopathymanickam, "Financial and management Accounting" PSG Publications.Fifth edition, 2009
7. https://nptel.ac.in/courses/110101004/17
8. https://nptel.ac.in/courses/110101003/

Course Contents and Lecture schedule

Module Number	Topics	No. of Lectures
1.0	**Cost management**	
1.1	An Overview of cost accounting	1
1.2	Objectives-scope of cost accounting	1
1.3	elements of cost- Cost centres and Cost units	2
1.4	Cost classification.	1
2.0	**Cost sheet**	
2.1	Meaning of overheads and its types	1
2.2	Preparation of cost sheet and analyse its applications.	2
3.0	**Material control**	
3.1	Necessity of material control	1
3.2	Methods of pricing of issues-FIFO,LIFO,HIFO	1
3.3	Simple average, weighted average, periodic average, replacement cost, base stock	2
3.4	Activity based costing	2
4.0	**Budgeting**	
4.1	Importance of Budget	1
4.2	Types of budget and their preparation	2
4.3	Standard costing- Variance analysis	2
5.0	**Financial management**	

Module Number	Topics	No. of Lectures
5.1	Importance, Objectives, and scope	1
5.2	Financial statement analysis	3
6.0	**Investment decision**	
6.1	Capital budgeting- Pay Back Period Method	1
6.2	Average Rate of Return	1
6.3	Internal Rate of Return	1
6.4	Profitability Index	1
6.5	Risk analysis	1
6.6	Working capital management	2
7	**Capital structure and Dividend Policies**	
7.1	Theory, planning	1
7.2	Dividend analysis	1
7.3	Dividend policy models	2
7.4	Share valuation	1
7.5	Source of finance	1
7.6	Financial institutions	1
	Total	**36**

Course Designers

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		Category	L	T	P	Credit
18IEPD0	**LEAN MANUFACTURING AND SIX SIGMA**	PE	3	0	0	3

Preamble

Lean manufacturing is a production practice that deals with the Identification and Elimination of waste in all levels of an organization. Lean is centered on preserving value with less work. Six - Sigma is a Business management Strategy that seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing the variability in manufacturing and business processes

Prerequisite

- Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Explain the concepts of Lean Manufacturing	Understand	80	70
CO2.	Construct a value stream mapping	Apply	70	60
CO3.	Explain various tools and techniques of six sigma	Understand	80	70
CO4.	Implement six sigma tools to minimize the variations in parameters of business models	Apply	70	60
CO5.	Evaluate Six Sigma practices in manufacturing and service sectors	Analyze	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	20	10	10	10
Understand	60	20	20	20
Apply	20	50	50	50
Analyse	0	20	20	20
Evaluate	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1.Extend the **purpose** of reducing waste

2.Explain push vs pull system.

3. Define DFMA

Course Outcome 2 (CO2):

1. For an automobile manufacturing company the following is the summary sheet

SI No	Description	Data
1.	Nature of Production System	Batch Production
2.	Set-up time	
	Heating	30 min
	Squeezing	45 min
	Bending	50 min
3.	Transfer of Material	Manual
4.	Mean time between failure	6 days
5.	Total man power	18 per day
6.	Work -in - Progress	2200 units
7.	Material travel distance	62ft
8.	No of machines involved	7
9.	Space Occupied	899 sq.ft

After several brain storming and a thorough study of the shop floor, it was observed that the tube subassembly line consists various forms of non-value-adding activities as follows: High lead time Accumulation of high inventory Unnecessary material flow High material travel distance Poor Mean-Time-Between-Failure ,underutilized manpower.

Organize the lean manufacturing practice using lean tools such as VSM, change overtime reduction and achieve the following targets

A. Reducing change-over time to 10 minutes.
B. Increasing the line productivity by 25%.
C. Reducing the WIP to 200 units improving the material flow

2. In a Copper smelter Maintenance the following are problems
   A. Frequent Breakdowns
   B.All Planned Maintenance activities are rescheduled
   C. No Preventive maintence available
   Execute the Total Productive Maintenance for solving above said problems

3. A Restaurant conducted consumer surveys and focus groups and identified the most important customer requirements as Healthy food, speedy service, an easy to read menu board, accurate order filling and perceived value. Develop of a set of technical requirements to incorporate into the design of a new facility and a house of quality relationship matrix to assess how well the requirements address these expectations.

Course Outcome 3 (CO3):

1. Explain the various steps in six sigma roadmap.

2. Compare Lean and Six sigma

3. Explain about DFSS methodology

Course Outcome 4 (CO4) :

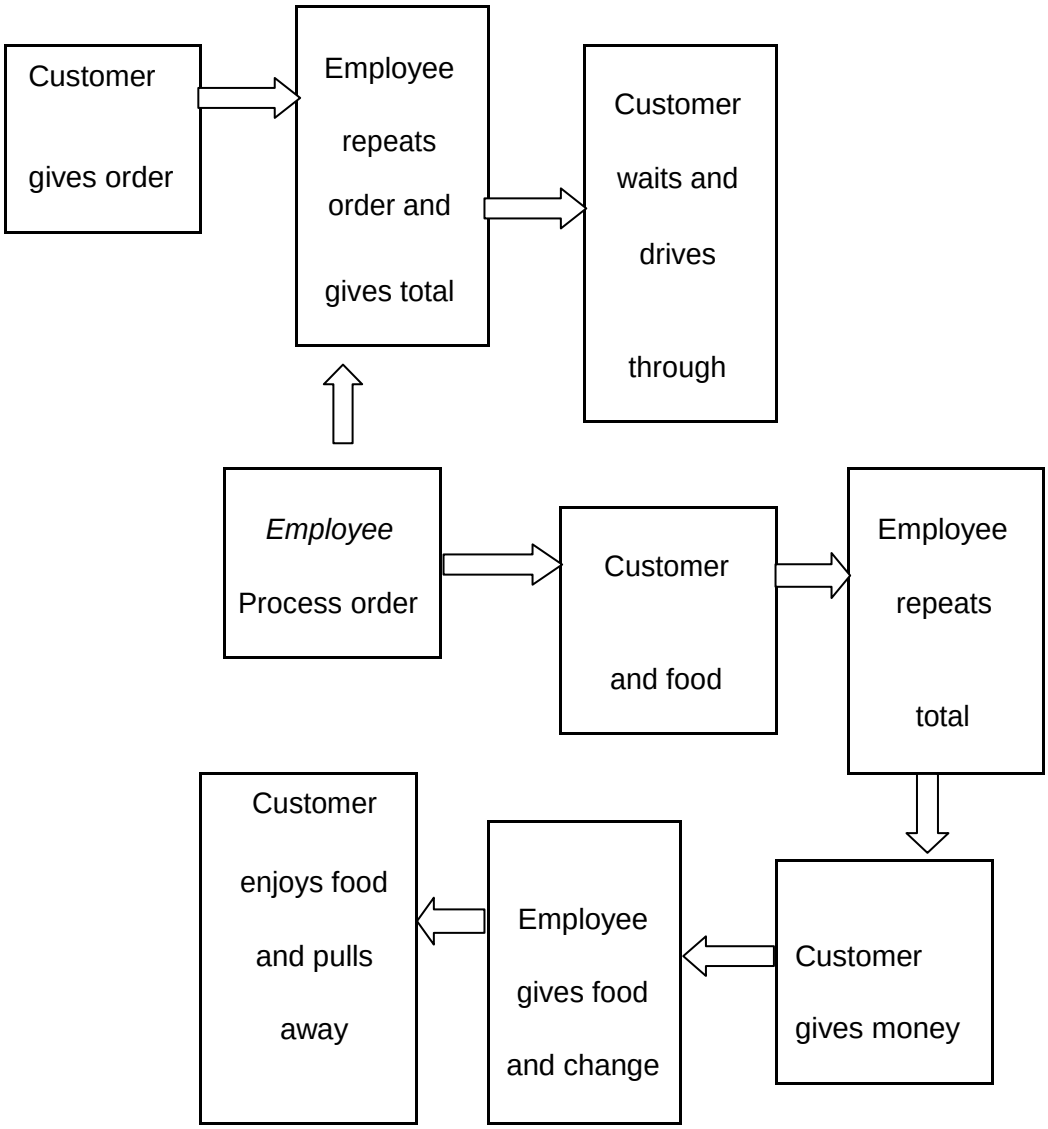
1. A car wash company recently faced a drastic drop in its client and in turn a huge revenue loss. How can this company improve the situation using Six Sigma?

2. From the given information box, draw the current state map, identify the wastes, draw the future state map suitably. Justify your answers. Also compare the takt time in both cases.

Part Number	WP/CAS/001	WP Casting
Family	Casting	Machine shop
Customer demand	4000/month	variation +400
Manufacturing data		Operation
Data collected by		Vinayaga
Cycle time(Minutes)		2
Change over time(Minutes)		20
Uptime		90%
% Defective		5% rework
Batch size		110 (10 numbers added to demand)
Number of shifts		2(8.5 hr per shift)
Number of Operators		1 per shift
Available time (Minutes)		450
Work in progress		650 numbers

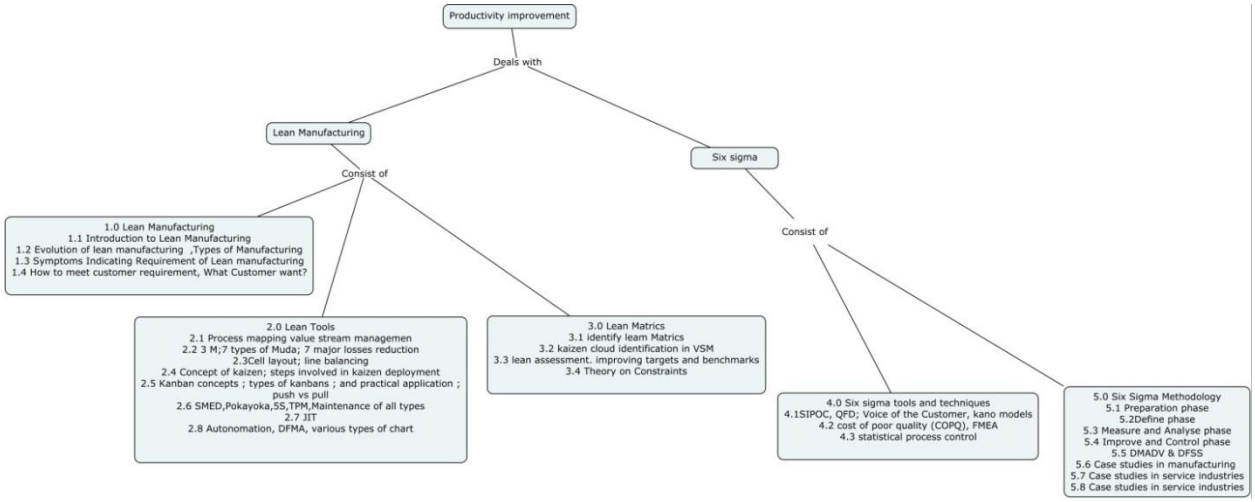
Course Outcome 5 (CO5):

1. A flow chart for a fast food drive through window is shown below. Categorize the important quality characteristics inherent in the process and suggest possible improvements using DMAIC cycle



2. In a Hospital a major dissatisfaction registered by patients is waiting time for surgery. from hospital's perceptive it resulted in increased costs and wasted resources. As for the patients and their family, it is a great inconvenience that their time is wasted. How can this problem has solved using Six Sigma? .

Concept Map



Syllabus

Lean Manufacturing evolution of lean; traditional versus lean manufacturing; ford production system concept of lean; Toyota's foray in lean, Customer Need; **lean tools-** Process mapping value stream management- 3 M;7 types of Muda; 7 major losses reduction. cell layout; line balancing; concept of kaizen; steps involved in kaizen deployment; kanban concepts ; types of Kanban ; and practical application ; push vs pull; changeover time reduction - single minute exchange of die; concept of TPM; poka-yoke; 5S; maintenance - preventive, time based and condition based; autonomous maintenance, JIT, Autonomation, DFMA; **lean metrics** identify lean metrics; kaizen cloud identification in Value Stream Mapping ; lean assessment. improving targets and benchmarks, Theory on Constraints

Six Sigma SIPCO,QFD; voice of the customer, kano models, , cost of poor quality (COPQ), **six sigma tools and techniques-** statistical process control **six sigma methods –** DMAIC, **Preparation phase:** Organizational success factors **–** leadership, six sigma as strategic initiative, internal communication strategy and tactics, formal launch, organizational structure, six sigma training plan, project selection, assessing organizational readiness, pitfalls. work as a process – vertical functions and horizontal processes. **Define phase:** DMAIC phases, overview, project charter – voice of the customer – high level process map –project team – case study. **Measure and analyse phase:** types of measures – use of statistical tools. Six sigma measurements – measurement system analysis – process capability calculations. analyze– process analysis – hypothesis testing – statistical tests and tables – tools for analyzing

relationships among variables – survival analysis. **Improve and control phase**: process redesign – generating improvement alternatives – design of experiments – pilot experiments – cost/benefit analysis – implementation plan. Control phase control plan – process scorecard – failure mode and effects analysis –final project report and documentation. DMADV,DFSS–six sigma in manufacturing and services case studies& Sustainability of Lean Six Sigma

Reference Books/ Learning Resources

1.Thomas Pyzdek, The Six Sigma Handbook , McGraw-Hill, 2014

2.James P. Womack , Daniel T. Jones ,Lean Thinking, Free press business,2013.

3.Kai Yang and Basemel-Haik, “Design for Six-Sigma: A Roadmap for Product Development”, McGraw Hill, 2009.

4.N.Gopalakrishnan, simplified lean manufacture:Elements, rules, tools and implementation, Prentice Hall of India, NewDelhi 2013

5.Michael L. George, David Rowlands, Bill Kastle ,What is Lean Six Sigma, Tata McGraw-Hill,2005

6."Learning to see" by Mike Rother ,John Shook 1999.

7.Lean and Six sigma in service Applications and case Studies by Sandra L.Furterer 2009.

8. MIT Open Courseware – **Introduction to Lean Six Sigma Methods.** Instructors - Prof. Earll Murman, Dr. Hugh McManus, Prof. Annalisa Weigel, Dr. Bo Madsen. URL: http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-660j-introduction-to-lean-six-sigma-methods-january-iap-2012/

9.**NPTEL Video Lectures – Six Sigma** – Prof. Tapan P. Bagchi. URL: http://nptel.ac.in/courses/110105039/

Course Contents and Lecture Schedule

S.No	Topics	No. of Lectures
1.0	**Lean Manufacturing**	
1.1	Introduction to Lean Manufacturing	1
1.1	Evolution of lean manufacturing ,Types of Manufacturing	1
1.2	Symptoms Indicating Requirement of Lean manufacturing	1
1.3	How to meet customer requirement, What Customer want?	1
2.0	**lean tools-**	

2.1	Process mapping value stream management	1
2.2	3 M;7 types of Muda; 7 major losses reduction	1
2.3	Cell layout; line balancing	1
2.4	Concept of kaizen; steps involved in kaizen deployment;	1
2.5	Kanban concepts ; types of kanbans ; and practical application ; push vs pull	1
2.6	SMED,Pokayoka,5S,TPM,Maintenance of all types	2
2.7	JIT	1
2.8	Autonomation, DFMA, various types of chart	2
3.0	**Lean Metrics**	
3.1	identify lean metrics	1
3.2	kaizen cloud identification in VSM	1
3.3	lean assessment. improving targets and benchmarks	1
3.4	Theory on Constraints	
4.0	**Six sigma tools and techniques**	
4.1	SIPOC, QFD; Voice of the Customer, kano models	1
4.2	cost of poor quality (COPQ), FMEA	1
4.3	statistical process control	1
5.0	**Six Sigma Methodology**	
5.1	Preparation phase	1
5.2	Define phase	2
5.3	Measure and Analyse phase	2
5.4	Improve and Control phase	2
5.5	DMADV & DFSS	3
5.6	Case studies in manufacturing	2
5.7	Case studies in service industries	2
5.8	Sustainability of Lean Manufacturing and Six sigma	1
	Total	36

Course Designers

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		Category	L	T	P	Credit
18IEPE0	**MACHINE LEARNING**	PE	3	0	0	3

Preamble

This course aims at the basic knowledge of Machine Learning. Machine learning (ML) is an application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

Prerequisite

Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Understand the techniques, mathematical concepts and algorithms used in machine learning.	Understand	75	60
CO2	Understand the limitations of various algorithms and evaluate the best suite for real world problems	Apply	75	60
CO3	Study the real world problems through generative and discriminative learning technique and apply related models fit for it such as neural networs, support vector machine,etc.	Apply	75	60
CO4	Design a prototype using regression or classification for supervised or unsupervised data.	Analyze	70	60
CO5	Examine the given data and find the best suitable data structure using machine learning algorithms	Analyze	70	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	0	0	0	0
Understand	60	20	20	20
Apply	40	60	60	60
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate Supervised and Unsupervised Learning
2. Differentiate logistic regression and linear regression
3. State the principles of Support Vector Machine.

Course Outcome 2 (CO2):

1. Differentiate forward and backpropogation.
2. How to estimate bias and variance?
3. Write the principle of Maximum Likelihood Estimation

Course Outcome 3 (CO3):

1. We have a bag of three biased coins a, b, and c with probabilities of coming up heads of 20%, 60%, and 80%, respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins), and then the coin is flipped three times to generate the outcomes X1, X2, and X3. Draw the Bayesian network corresponding to this setup and define the necessary CPTs.
2. Construct a support vector machine for the below given data using SMO algorithm.

Year	Sales (Million Euro)	Advertising (Million Euro)
1	651	23
2	762	26
3	856	30
4	1,063	34
5	1,190	43
6	1,298	48
7	1,421	52
8	1,440	57
9	1,518	58

5.

3. Draw the localized network structure (neural network) for the given scenario.

Course Outcome 4 (CO4):

1. Last year, five randomly selected students took a math aptitude test before they began their statistics course. The Statistics Department has three questions.
   a) What linear regression equation best predicts statistics performance, based on math aptitude scores?
   b) If a student made an 80 on the aptitude test, what grade would we expect her to make in statistics?
   c) How well does the regression equation fit the data?

   In the table below, the x_i column shows scores on the aptitude test. Similarly, the y_i column shows statistics grades.

Student	x_i	y_i
1	95	85
2	85	95
3	80	70
4	70	65
5	60	70

2. The table given below shows some data from the early days of the Italian clothing company Benetton. Each row in the table shows Benetton's sales for a year, and the amount spent on advertising in that year. In this case, our *outcome* of interest is sales. If we use *Advertising* as the predictor variable, linear regression estimates that **Sales = 168 + 23 Advertising**. That is, if advertising expenditure is increased by one Euro, then sales will be expected to increase by 23 million Euro, and if there was no advertising what would be the expected sales of 168 million Euro.

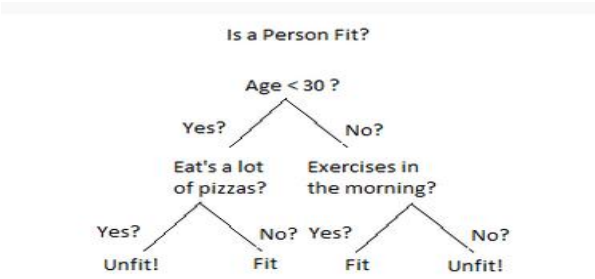
Year	Sales (Million Euro)	Advertising (Million Euro)
1	651	23
2	762	26
3	856	30
4	1,063	34
5	1,190	43
6	1,298	48
7	1,421	52
8	1,440	57
9	1,518	58

3. For the given data, Predict Y from X using linear regression.

X	Y
1.00	1.00
2.00	2.00
3.00	1.30
4.00	3.75
5.00	2.25

Course Outcome 5(CO5):

1. Predict whether a person is fit given their information like age, eating habit, and physical activity, etc.

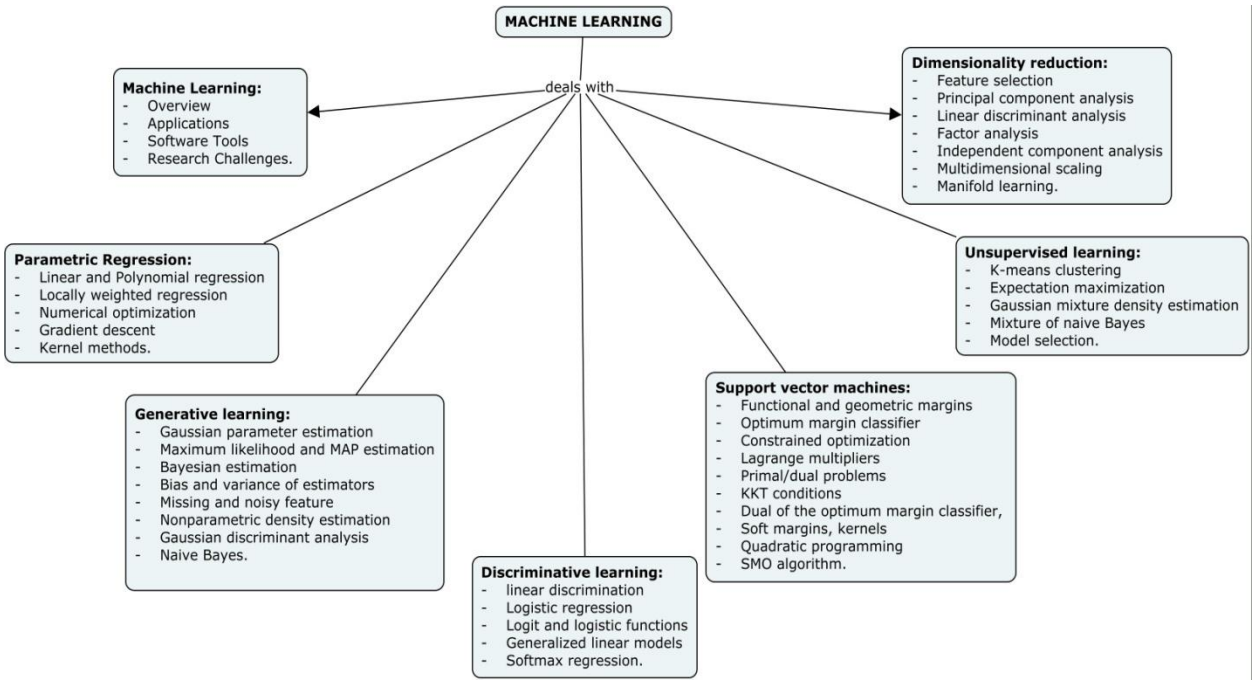


2. From the given table, predict whether it is possible to play on Saturday?

Day	Weather	Temperature	Humidity	Wind	Play?
1	Sunny	Hot	High	Weak	No
2	Cloudy	Hot	High	Weak	Yes
3	Sunny	Mild	Normal	Strong	Yes
4	Cloudy	Mild	High	Strong	Yes
5	Rainy	Mild	High	Strong	No
6	Rainy	Cool	Normal	Strong	No
7	Rainy	Mild	High	Weak	Yes
8	Sunny	Hot	High	Strong	No
9	Cloudy	Hot	Normal	Weak	Yes
10	Rainy	Mild	High	Strong	No

3. Train the system having images of both cat and dog using neural network and predict whether the given image is cat or not.

Concept Map



Syllabus

Machine Learning: Overview – Applications – Software Tools - Research Challenges.

Parametric Regression: Linear regression, polynomial regression, locally weighted regression, numerical optimization, gradient descent, kernel methods.

Generative learning: Gaussian parameter estimation, maximum likelihood estimation, MAP estimation, Bayesian estimation, bias and variance of estimators, missing and noisy features, nonparametric density estimation, Gaussian discriminant analysis, naive Bayes.

Discriminative learning: linear discrimination, logistic regression, logit and logistic functions, generalized linear models, softmax regression.

Support vector machines: Functional and geometric margins, optimum margin classifier, constrained optimization, Lagrange multipliers, primal/dual problems, KKT conditions, dual of the optimum margin classifier, soft margins, kernels, quadratic programming, SMO algorithm.

Unsupervised learning: K-means clustering, expectation maximization, Gaussian mixture density estimation, mixture of naive Bayes, model selection.

Dimensionality reduction: feature selection, principal component analysis, linear discriminant analysis, factor analysis, independent component analysis, multidimensional scaling, manifold learning.

Reference Books

1. Tom M. Mitchell. **"Machine Learning"**, McGraw Hill Education, Indian edition, 2017.
2. E. Alpaydin , "**Machine Learning**", MIT Press, 2010.
3. Willi Richert and Luis Pedro Coelho., "**Building Machine Learning Systems with Python**", Packt Publishing Limited, 2013.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1	**Machine Learning**	
1.1	Overview, Applications	1
1.2	Software Tools, Research Challenges	1
2	**Parametric Regression**	
2.1	Linear regression	1
2.2	Polynomial regression, locally weighted regression	1
2.3	Numerical optimization, gradient descent	1
2.4	Kernel methods	1
3	**Generative learning**:	
3.1	Gaussian parameter estimation	1
3.2	Maximum likelihood estimation - MAP estimation	1
3.3	Bayesian estimation, bias and variance of estimators, missing and	2

Module No.	Topics	No. of Lectures
	noisy features	
3.4	Nonparametric density estimation, Gaussian discriminant analysis, naive Bayes	2
4	**Discriminative learning**	
4.1	Linear discrimination, logistic regression	1
4.2	Logit and logistic functions	1
4.3	Generalized linear models	1
4.4	softmax regression	1
5	**Support vector machines**	
5.1	Functional and geometric margins	1
5.2	Optimum margin classifier, constrained optimization	1
5.3	Lagrange multipliers, primal/dual problems,	2
5.4	KKT conditions, dual of the optimum margin classifier	2
5.6	Soft margins, kernels, quadratic programming	2
5.7	SMO algorithm	1
6	**Unsupervised Learning**	
6.1	K-means Clustering	1
6.2	Expectation Maximization, Gaussian mixture density estimation	2
6.3	Mixture of naive Bayes, model selection.	1
7	**Dimensionality Reduction**	
5.1	Feature Selection	1
5.2	Principal Component Analysis	1
5.3	L1inear Discriminant Analysis	1
5.4	Factor Analysis	1
5.5	Independent component analysis	1
5.6	Multidimensional Scaling	1
5.7	Manifold Learning	1
	Total	**36**

Course Designers:

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		Category	L	T	P	Credit
18MGPH0	**MACHINE VISION**	PE	3	0	0	3

Preamble

Machine Vision has become a key technology in the area of manufacturing and quality control. Increasing quality demands require inspection of every single part which in turn will lead to much more wide spread use of visual inspection systems. Furthermore the documentation requirements and quality control standards can only be met by fully automated networked inspection systems. The Success of developing machine vision system depends on the understanding all parts of the imaging chain. Hence this course discusses about image acquisition, lens and illumination systems, image preprocessing and processing, segmentation and classification techniques used in a typical machine vision application.

Prerequisite

Nil

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO 1.	Explain the components of a machine vision system.	Understand	70	80
CO 2.	Select appropriate camera, lens and lighting system for a machine vision system to meet the required manufacturing requirement	Apply	60	70
CO 3.	Select appropriate image preprocessing and post processing techniques such as enhancement, segmentation for the given application	Apply	60	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	10

Understand	50	50	40	40
Apply	20	30	40	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the working principle of CCD sensor array
2. Describe in detail about various image acquisition modes.
3. Explain the advantages of CMOS sensors over CCD sensors.

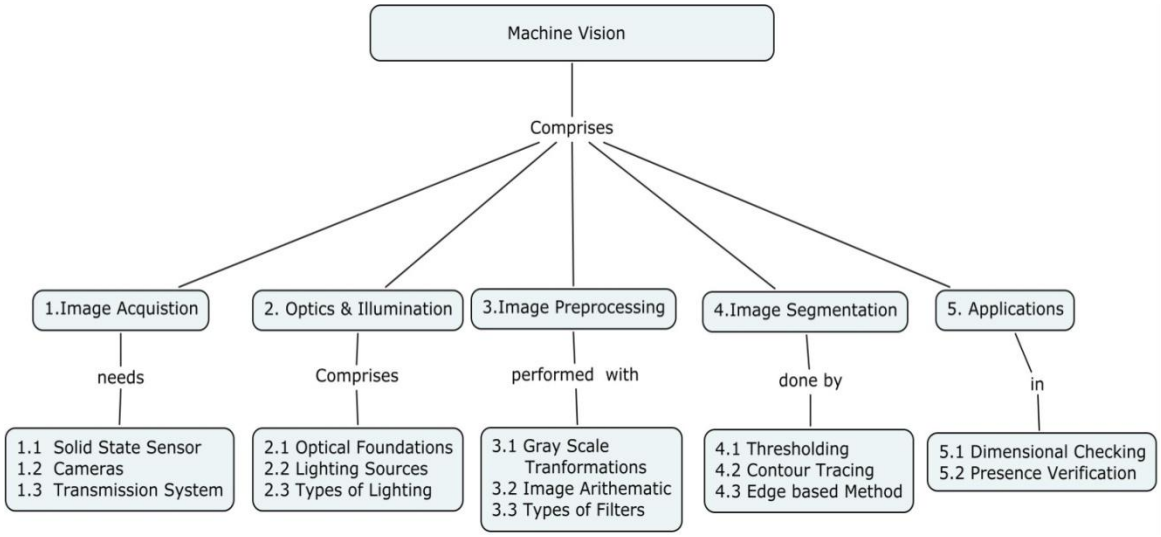
Course Outcome 2 (CO2):

1. Determine the focal length of a lens of a vision system requiring a magnification of 0.06 and a working distance of 80 cm.
2. Determine the Magnification of the vision system and the size of the pixel on the sensor, if the size of 200 X 200 solid state sensor array is 40mmX40mm and the size of the object to be measured is 60mmX60mm.
3. Determine the focal length, magnification, Depth of field for an industrial installation inspecting flat plates on a moving conveyor belt with front lighting. You have a solid state camera with 100X 100 array sensor. Sensor dimensions .03X.03 cm. Distance between the lens and work piece is 60 cm.b F-Stop is 8, and there are 16 grey level and 30 images / second. Object dimensions are 7.5 X 7.5 X 1.2 cm. The object occupies 50% of sensor array.

Course Outcome 3 (CO3):

1. Select and illustrate a suitable Machine Vision Technique used for Inspection of Threads in Nuts in a Batch Production Process.
2. A surveillance camera is embedded in one of the walls of a room . The optical axis of the camera is perpendicular to the wall, and the lens centre is in the plane of the wall. The focal length of the lens is .05m.The X-Z plane of the camera is parallel to the X-Y Plane of the world coordinate system. The image plane is behind the wall. Find the image plane coordinates of (a) the room corner A and (b) the head of a person 2m tall standing at a distance of 3m X 2m from the corner
3. Determine the dimensions of the largest object that can be imaged by a vision system with a magnification of 0.1, a 5 X 5 mm sensor array with 50 X 50 elements. The distance from the object to the lens is 60 cm and F-Stop is 16.

Concept Map



Syllabus

Image Acquisition Solid State Sensors CCD Sensor Operation, Properties, Image Degradation. Standard Video Cameras: Basic Structure, Sampling of Line Signal and Extension of Video Standards, Image Quality, Progressive Scan Cameras, Asynchronous Camera, Digital Camera, Line Scan Cameras, Line Scan Cameras and its Properties. Transmission to Computer: Basic operation of Frame Grabber and Direct Digital transmission. Interfaces: FireWire, Camera Link, GigE, and USB. **Optics and Illumination** Optical foundations: F number, Thin Lens Imaging Equation, Depth of Field, Typical Imaging Situations, Aberrations, Lens Selection, Special Optical devices. Light Sources, Types of Light Filters, Types of Lighting: Diffuse, Directed, Telecentric, Structured, Bright field, Dark Field, Incident and Transmitted Lighting.

Image Preprocessing Gray Scale Transformations: Look up tables, Linear Gray level scaling, Contrast enhancement, Histogram equalization, Local Contrast Enhancement. Image Arithmetic: Image Addition, Subtraction and Averaging, Minimum and Maximum of two images. Types of Filters: Linear Filters, Median Filter, Morphological and Non Linear Filters. **Image Segmentation** Threshold Determination from Histogram, Gray Level Histogram, Generalizations of Thresholding Contour Tracing: Pixel Connectedness, Generating Object Contours, Contour representation Edge based Methods: Edge probing and Edge Detection Template matching: Basic Operation, Optimizing and Comments on Template Matching. **Applications:** Dimensional Checking: Simple gauging, Shape Checking, Angle Gauging, High accuracy Gauging, Calibration. Presence Verification: Simple Presence verification, Simple Gauging for assembly verification, Glue Check under UV Light, Pin type Verification Alignment Checking.

Reference Books

1. C. Demant, B.Streicher Abel, P.Waszkewitz “Industrial Image Processing and Visual Quality control in manufacturing”. Springer, 2013.
2. Rafel C.Gonzalez, Richard E.Woods, “Digital Image Processing.” Third Edition, Prentice Hall India, 2007.

3. Nello Zeuch, “Understanding and Applying Machine Vision, Second Edition, Revised and Expanded (Manufacturing Engineering and Materials Processing)” Marcel Dekker Inc., 2000
4. Alexander Hornberg, “Handbook of Machine Vision”, Wiley VCH, 2006
5. https://www.visiononline.org/certified-vision-professional-basic-training
6. Edmund Optics Imaging Lab
7. http://www.cse.usf.edu/~r1k/MachineVisionBook/MachineVision.pdf
8. http://www.machinevision.co.uk/
9. nptel.ac.in/courses/117105079

Course Contents and Lecture Schedule

Module Number	Topics	No. of Lectures
1	**Image Acquisition**	
1.1	Solid State Sensors:	1
1.1.1	CCD Sensor Operation	1
1.1.2	CCD Properties, Image Degradation	
1.1.3	CMOS Sensors Operation and its advantages	1
1.2	Standard Video Cameras:	
1.2.1	Basic Structure, Sampling of Line Signal	1
1.2.2	Extension of Video Standards, Image Quality	1
1.2.3	Progressive Scan Cameras, Asynchronous Camera, Digital Camera, Line Scan Cameras and its Properties	1
1.3	Transmission to Computer:	
1.3.1	Basic operation of Frame Grabber	1
1.3.2	Direct Digital transmission	
1.3.3	USB, IEEE1394, Firewire, Gigabit Ethernet, Geni CAM, Cameralink	1
2	**Optics and Illumination**	
2.1	Optical foundations:	1
2.1.1	Basic Laws of Optics, F number, Thin Lens Imaging Equation, Depth of Field	1
2.1.2	Typical Imaging Situations, Aberrations	1
2.1.3	Lens Selection, Special Optical devices	1
2.2	Lighting Sources	
2.2.1	Incandescent Lamps, Metal Vapour Lamps, Xenon Lamps, Fluorescent, LED, Laser.	1
2.2.2	Types of Light Filters – UV Filter, Day Light Filter, IR Filter Gray Filter, Polarization Filter, Color Filter and Combination.	1
2.3	Types of Lighting	
2.3.1	Diffuse and Directed Bright Field Incident Lighting.	1
2.3.2	Telecentric and Structured Bright Field Incident Lighting Diffuse and Directed Dark Field Incident Lighting	2
2.3.3	Diffuse and Directed transmitted Lighting - Bright Field and Dark Field	1
3	**Image Preprocessing**	

Module Number	Topics	No. of Lectures
3.1	Gray Scale Transformations:	
3.1.1	Look up tables, Linear Gray level scaling	1
3.1.2	Contrast enhancement, Histogram equalization, Local Contrast Enhancement.	2
3.1.3	Image Arithmetic: Image Addition, Subtraction and Averaging, Minimum and Maximum of two images.	1
3.1.4	Types of Filters: Linear Filters, Median Filter	1
3.1.5	Morphological and Non Linear Filters	1
4	**Image Segmentation**	
4.1	Thresholding:	
4.1.1	Threshold Determination from Histogram	1
4.1.2	Gray Level Histogram, Generalizations of Thresholding	1
4.2	Contour Tracing:	
4.2.1	Pixel Correctedness, Generating Object Contours, Contour representation	2
4.2.2	Edge based Methods: Edge probing and Edge Detection	1
4.2.3	Template matching: Basic Operation, Optimizing and Comments on Template Matching.	1
5	**Applications**	
5.1	Dimensional Checking:	
5.1.1	Simple gauging, Shape Checking	1
5.1.2	Angle Gauging, High accuracy Gauging	1
5.1.3	Calibration	1
5.2	Presence Verification:	
5.2.1	Simple Presence verification, Simple Gauging for assembly verification	
5.2.2	Glue Check under UV Light	2
5.2.3	Pin Type Verification	2
5.2.4	Alignment Checking	
	Total	37

Course Designers:

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18IEPG0	MAINTENANCE ENGINEERING AND RISK MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To impart knowledge in the fields of Maintenance engineering, maintainability, maintenance budgeting and risk management. Express about the importance of risk, types and its management requirements.

Prerequisite

NIL

Course Outcomes

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

CO.No	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO 1.	Choose suitable Maintenance plan for the given situation	Apply	70	60
CO 2.	Determine the optimal replacement period and cost	Apply	70	60
CO 3.	Prepare maintenance job schedule using different techniques	Apply	70	60
CO 4.	Estimate the maintenance budget for the given plan	Apply	70	60
CO 5.	Explain the processes of evaluation in Maintenance	Understand	80	70
CO 6.	Assess and Mitigate the risks involved in the given system.	Apply	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1.		M	S		M	M			M	M	M
CO 2.	S	S	S		M	M	M				
CO 3.		S	M	M	M				M	M	M
CO 4.	S	S	M	M	M		S			M	M
CO 5.			M	M			M			M	M
CO 6.	S	M	S	M	M		S	M	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	10	10
Understand	30	30	30	30
Apply	50	50	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. Discuss the salient features of planned maintenance and unplanned maintenance plans.
5. Deliberate about Reliability based maintenance and Condition based maintenance and its implementation requirements.
6. Inform about the requirements of different maintenance plans and its effects on the system availability.
7. Consider a system with three components A, B and C in parallel. Determine the system reliability for 2000 h of operation, and find the mean time to failure. Assume all the three components have an identical time-to failure distribution that is exponential, with a constant failure rate of 0.0006 per hour. What is the mean time failure of each component?

Course Outcome 2 (CO2):

1. A machine owner finds from his past records that the costs per year of maintaining a machine whose purchase price is Rs.6000 are as given below:

Year	1	2	3	4	5	6
Maintenance Cost (Rs.)	1000	1200	1400	1800	2300	2800
Resale value	3000	1500	750	375	200	200

Determine at what age is replacement due?

2. A manufacturer is offered two machines A and B. A is priced at Rs.5000 and running costs are estimated at Rs.800 for each of the first five years, increasing by Rs.200 per year in the sixth and subsequent years. Machine B, which has the same capacity as A, costs Rs.2500 but will have running costs of Rs.12000 per year for six years, increasing by Rs.200 per year thereafter. If money is worth 10% per year which machine should be purchased? Assume that the machines will eventually be sold for scrap at a negligible price.

3. The following failure rates have been observed for a certain type of light bulb.

End of week	1	2	3	4	5	6	7
Probability of failure	0.05	0.15	0.25	0.46	0.68	0.88	1.00

The cost of replacing an individual failed bulb is Rs.1.25. If the cost of group replacement is 90 paise per bulb, determine among individual and group replacement policies which one is better.

Course Outcome 3 (CO3):

1. Discuss about planning and scheduling of maintenance for a given system concern.
2. Illustrate the different techniques used in maintenance scheduling.
3. Preparation of work orders and job schedules using CMMS.
4. Describe about the various components of TPM.

Course Outcome 4 (CO4):

1. Illustrate various components of maintenance costs involved in maintenance budget preparation.
2. Preparation of Maintenance budget for a given organization and suggest the ways to minimize the costs.

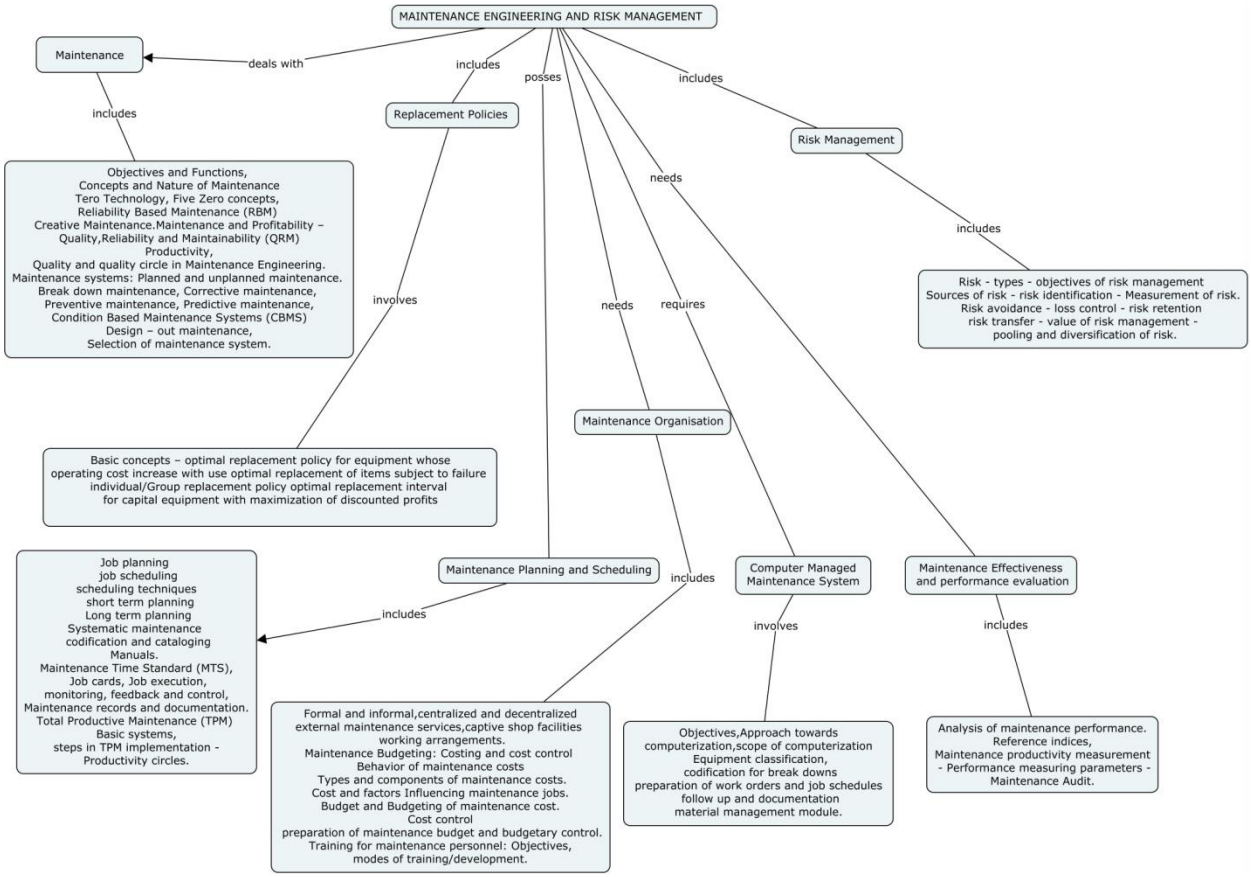
Course Outcome 5 (CO5):

1. Explain about the maintenance performance indices and its usage.
2. Discuss about the outcomes of maintenance audit.
3. Express the typical content of a maintenance audit report.

Course Outcome 6 (CO6):

1. Discuss the sources and identification of risk.
2. Deliberate the measurement of risk for the given system concern.
3. Inform about the risk management techniques suitable for the given situations.

Concept Map



Syllabus

Maintenance: Objectives and Functions, Concepts and Nature of Maintenance, Tero Technology, Five Zero concepts, Reliability Based Maintenance (RBM), Creative Maintenance. Maintenance and Profitability – Quality, Reliability and Maintainability (QRM) – Productivity, Quality and quality circle in Maintenance Engineering. Maintenance systems: Planned and unplanned maintenance. Break down maintenance, Corrective maintenance, Preventive maintenance, Predictive maintenance, Condition Based Maintenance Systems (CBMS), Design – out maintenance, Selection of maintenance system.

Replacement Policies - Basic concepts – optimal replacement policy for equipment whose operating cost increase with use – optimal replacement of items subject to failure – individual/Group replacement policy – optimal replacement interval for capital equipment with maximization of discounted profits.

Maintenance Planning and Scheduling: Job planning – job scheduling – scheduling techniques – short term planning, Long term planning – Systematic maintenance – codification and cataloging, Manuals. Maintenance Time Standard (MTS), Job cards, Job execution, monitoring, feedback and control, Maintenance records and documentation. Total Productive Maintenance (TPM) – Basic systems, steps in TPM implementation - Productivity circles.

Maintenance organization: Formal and informal – centralized and decentralized – external maintenance services – captive shop facilities – working arrangements. Maintenance Budgeting: Costing and cost control – Behavior of maintenance costs – Types and components of maintenance costs. Cost and factors Influencing maintenance jobs. Budget and Budgeting of maintenance cost. Cost control – preparation of maintenance budget and budgetary control. Training for maintenance personnel: Objectives, modes of training/development.

Computer Managed Maintenance System (CMMS): Objectives, Approach towards computerization – scope of computerization – Equipment classification – codification for break downs – preparation of work orders and job schedules – follow up and documentation – material management module.

Maintenance Effectiveness and performance evaluation: Analysis of maintenance performance. Reference indices, Maintenance productivity measurement - Performance measuring parameters - Maintenance Audit.

Risk Management: Risk - types - objectives of risk management - Sources of risk - risk identification - Measurement of risk. Risk avoidance - loss control - risk retention - risk transfer - value of risk management - pooling and diversification of risk.

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
1	**Maintenance**	
1.1	Objectives and Functions, Concepts and Nature of Maintenance	1
1.2	Tero Technology, Five Zero concepts	1
1.3	Reliability Based Maintenance (RBM), Creative Maintenance	1
1.4	Maintenance and Profitability – Quality, Reliability and Maintainability (QRM) – Productivity, Quality	2
1.5	quality circle in Maintenance Engineering	1
1.6	Maintenance systems: Planned and unplanned maintenance. Break down maintenance,	1
1.7	Corrective maintenance, Preventive maintenance	1
1.8	Predictive maintenance, Condition Based Maintenance Systems (CBMS)	1

Module Number	Topic	No. of Lectures
1.9	Design – out maintenance, Selection of maintenance system.	1
2	**Replacement Policies**	
2.1	Basic concepts – optimal replacement policy for equipment whose operating cost increase with use – optimal replacement of items subject to failure	2
2.2	individual/Group replacement policy – optimal replacement	1
2.3	interval for capital equipment with maximization of discounted profits	1
3	**Maintenance Planning and Scheduling:**	
3.1	Job planning – job scheduling – scheduling techniques – short term planning, Long term planning –	1
3.2	Systematic maintenance – codification and cataloging,	1
3.3	Manuals. Maintenance Time Standard (MTS), Job cards, Job execution, monitoring, feedback and control, Maintenance records and documentation.	1
3.4	Total Productive Maintenance (TPM) – Basic systems, steps in TPM implementation - Productivity circles.	1
4	**Maintenance organization**	
4.1	Formal and informal – centralized and decentralized – external maintenance services – captive shop facilities – working arrangements.	2
4.2	Maintenance Budgeting: Costing and cost control – Behavior of maintenance costs –	1
4.3	Types and components of maintenance costs.	1
4.4	Cost and factors Influencing maintenance jobs. Budget and Budgeting of maintenance cost. Cost control – preparation of maintenance budget and budgetary control.	1
4.5	Training for maintenance personnel: Objectives, modes of training/development.	1
5	**Computer Managed Maintenance System (CMMS)**	
5.1	Objectives, Approach towards computerization – scope of computerization	1
5.2	Equipment classification – codification for break downs	1
5.3	Preparation of work orders and job schedules	1
5.4	Follow up and documentation – material management module.	1
6	**Maintenance Effectiveness and performance evaluation**	
6.1	Analysis of maintenance performance. Reference indices	1
6.2	Maintenance productivity measurement	1
6.3	Performance measuring parameters - Maintenance Audit.	1

Module Number	Topic	No. of Lectures
7	**Risk Management**	
7.1	Risk - types - objectives of risk management	1
7.2	Sources of risk - risk identification - Measurement of risk.	1
7.3	Risk avoidance - loss control - risk retention	1
7.4	Risk transfer - value of risk management	1
7.5	Pooling and diversification of risk.	1
	\ Total	**36**

Reference Books

1. A.K.S.Jardine and A.H.C. Tsang, “Maintenance, replacement, and reliability: theory and applications”, CRC/Taylor & Francis, 2013.
2. Anteny Kelly , “Strategic Maintenance planning”, Butterworth-Heinemann, 2006.
3. Gopalakrishnan, P. Banerji, A.K, “Maintenance and Spare Parts Management”, Prentice Hall of India, 2011.
4. Sushil Kumar Srivastava, “Industrial Maintenance Management”, S.Chand and Company Ltd., 2005.
5. Stulz Rene. "Risk Management and Derivatives" Cengage South-Western, 2nd edition, 2011.
6. E-learning resource: www.technav.ieee.org/tag/1451/maintenance-engineering
7. E-learning resource: https://nptel.ac.in/courses/112105048/1, IIT Kharagpur

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		Category	L	T	P	Credit
18IEPH0	**MARKETING MANAGEMENT**	PE	3	0	0	3

Preamble

Marketing management is a business discipline which is focused on the practical application of marketing techniques and the management of a firm's marketing resources and activities. Marketing managers are often responsible for influencing the level, timing, and composition of customer demand. Branding aims to establish a significant and differentiated presence in the market that attracts and retains loyal customers. Digital marketing is the marketing of products or services using digital technologies, mainly on the Internet, and any other digital medium.

Prerequisite

NIL

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Explain the concepts of marketing management and its environment	Understand	80	70
CO2.	Illustrate suitable marketing research plan for various application	Apply	70	60
CO3.	Apply various marketing development strategies to improve product life cycle.	Apply	70	60
CO4.	Select suitable pricing and branding methods in market place	Analyze	70	60
CO5.	Identify a suitable consumer behavior to market a product	Apply	70	60
CO6.	Explain the concepts of Digital Marketing	Understand	80	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20

Understand	30	30	30	30
Apply	50	40	50	40
Analyze		10		10
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define marketing.
2. List the importance of marketing management.
3. List the objectives of marketing management.
4. Differentiate sales management and marketing management.

Course Outcome 2 (CO2):

1. Write the need of marketing research.
2. List the type of marketing research.
3. Define the term marketing process.

Course Outcome 3 (CO3):

1. Define product life cycle.
2. Discuss the marketing strategies throughout the product life cycle.
3. Build a suitable strategy to develop product life cycle.
4. Explain the importance of life cycle management of a product.

Course Outcome 4 (CO4):

1. Define pricing.
2. List the pricing methods.
3. Describe the role of middle man in distribution channel.
4. Define branding.
5. Analyze the importance of branding with suitable FMCG product.

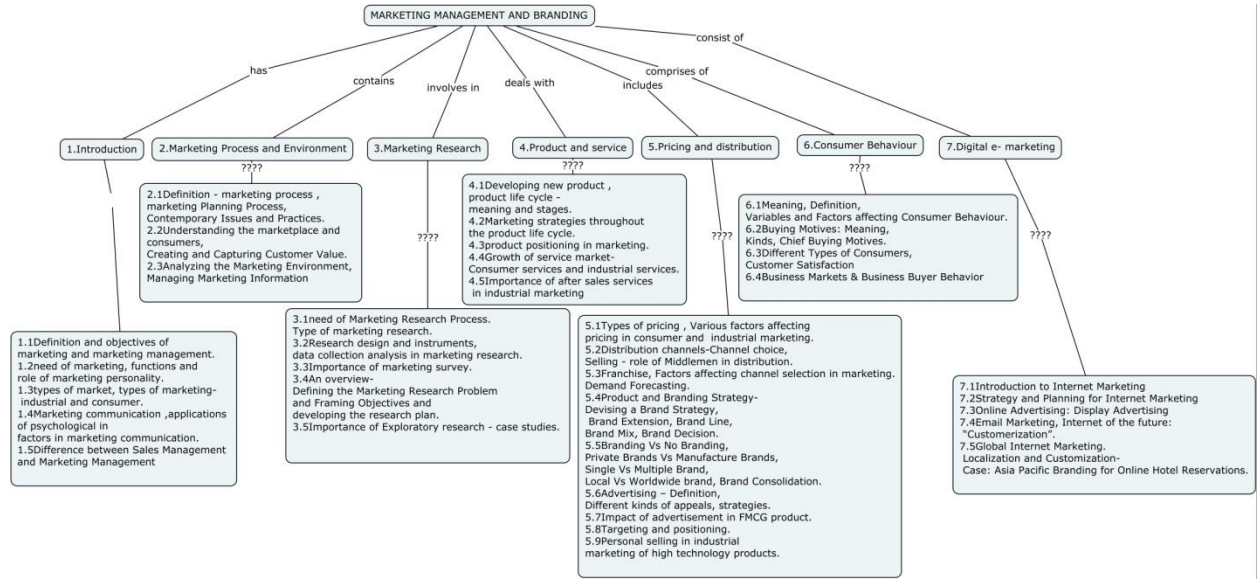
Course Outcome 5 (CO5):

1. List the factors affecting consumer behavior.
2. Explain the different types of customers.
3. Analyze the issues in marketing automobile products in a developing country like India.

Course Outcome 6 (CO6):

1. List the advantages of internet marketing.
2. Define Customerization.
3. Illustrate the current scenario of global marketing with an example.
4. Define online advertising.

Concept Map



Syllabus

Introduction: Definition and objectives of marketing and marketing management. need of marketing, functions and role of marketing personality. types of market, types of marketing-industrial and consumer. Marketing communication ,applications of psychological in factors in marketing communication. Difference between Sales Management and Marketing Management

Marketing Process and Environment: Definition - marketing process ,marketing Planning Process, Contemporary Issues and Practices. Understanding the marketplace and consumers, Creating and Capturing Customer Value. Analyzing the Marketing Environment, Managing Marketing Information.

Marketing Research: Need of Marketing Research Process. Type of marketing research. Research design and instruments, data collection analysis in marketing research. Importance of marketing survey. An overview- Defining the Marketing Research Problem and Framing Objectives and developing the research plan. Importance of Exploratory research. case studies.

Product and service: Developing new product , product life cycle - meaning and stages. Marketing strategies throughout the product life cycle. product positioning in marketing,
Growth of service market- Consumer services and industrial services. Importance of after sales services in industrial marketing

Pricing and Branding: Types of pricing , Various factors affecting pricing in consumer and industrial marketing. Distribution channels-Channel choice, Selling - role of Middlemen in distribution. Franchise, Factors affecting channel selection in marketing. Demand Forecasting , Product and Branding Strategy- Devising a Brand Strategy, Brand Extension, Brand Line, Brand Mix, Brand Decision. Branding Vs No Branding, Private Brands Vs Manufacture Brands, Single Vs Multiple Brand, Local Vs Worldwide brand, Brand Consolidation. Advertising – Definition, Different kinds of appeals, strategies. Impact of advertisement in FMCG product.
Targeting and positioning. Personal selling in industrial marketing of high technology products.

Consumer Behavior: Meaning, Definition, Variables and Factors affecting Consumer Behaviour. Buying Motives: Meaning, Kinds, Chief Buying Motives. Different Types of Consumers, Customer Satisfaction. Business Markets & Business Buyer Behavior

Digital Marketing: Introduction to Internet Marketing. Strategy and Planning for Internet Marketing. Online Advertising, Display Advertising, Email Marketing, Internet of the future: "Customerization".
Global Internet Marketing. Localization and Customization- Case studies.

Reference Book

1. Gupta, S.L., Sales and Distribution Management, Excel Books, New Delhi, 2008.
2. Philip Kotler, **"Marketing Management",** Prentice Hall of India, New Delhi, 2001.
3. Sharma Gulnar and Singh Karan Khundia, Brand Management, Himalyan Publishing Houser, Edition 2012.
4. https://nptel.ac.in/courses/110104068/
5. https://nptel.ac.in/courses/110104070/
6. https://nptel.ac.in/courses/110107112/

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
1	**Introduction**	
1.1	Definition and objectives of marketing and marketing management.	1
1.2	need of marketing, functions and role of marketing personality.	1
1.3	types of market, types of marketing- industrial and consumer.	1
1.4	Marketing communication ,applications of psychological in factors in marketing communication.	1
1.5	Difference between Sales Management and Marketing Management	1
2	**Marketing Process and Environment**	
2.1	Definition - marketing process ,marketing Planning Process, Contemporary Issues and Practices.	1
2.2	Understanding the marketplace and consumers, Creating and Capturing Customer Value.	2
2.3	Analyzing the Marketing Environment, Managing Marketing Information	1
3	**Marketing Research**	
3.1	need of Marketing Research Process. Type of marketing research.	1
3.2	Research design and instruments, data collection analysis in marketing research.	1
3.3	Importance of marketing survey.	1
3.4	An overview- Defining the Marketing Research Problem and Framing Objectives and developing the research plan.	2
3.5	Importance of Exploratory research. - case studies.	1
4	**Product and service**	1
4.1	Developing new product , product life cycle - meaning and stages.	1
4.2	Marketing strategies throughout the product life cycle.	1
4.3	product positioning in marketing.	1
4.4	Growth of service market- Consumer services and industrial services.	1
4.5	Importance of after sales services in industrial marketing	1
5	**Pricing and Branding**	

Module Number	Topic	No. of Lectures
5.1	Types of pricing , Various factors affecting pricing in consumer and industrial marketing.	1
5.2	Distribution channels-Channel choice, Selling - role of Middlemen in distribution.	1
5.3	Franchise, Factors affecting channel selection in marketing.Demand Forecasting.	1
5.4	Product and Branding Strategy- Devising a Brand Strategy, Brand Extension, Brand Line, Brand Mix, Brand Decision.	1
5.5	Branding Vs No Branding, Private Brands Vs Manufacture Brands, Single Vs Multiple Brand, Local Vs Worldwide brand, Brand Consolidation.	1
5.6	Advertising – Definition, Different kinds of appeals, strategies.	1
5.7	Impact of advertisement in FMCG product.	1
5.8	Targeting and positioning.	1
5.9	Personal selling in industrial marketing of high technology products.	1
6	**Consumer Behavior**	
6.1	Meaning, Definition, Variables and Factors affecting Consumer Behavior.	1
6.2	Buying Motives: Meaning, Kinds, Chief Buying Motives.	1
6.3	Different Types of Consumers, Customer Satisfaction	1
6.4	Business Markets & Business Buyer Behavior	1
7	**Digital e- marketing**	
7.1	Introduction to Internet Marketing	1
7.2	Strategy and Planning for Internet Marketing	1
7.3	Online Advertising: Display Advertising	1
7.4	Email Marketing, Internet of the future: “Customerization”.	1
7.5	Global Internet Marketing. Localization and Customization- Case: Asia Pacific Branding for Online Hotel Reservations.	1
	Total	**39**

Course Designers

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18MGPQ0	PLANT LAYOUT AND MATERIAL HANDLING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The workplace is one of the prime resources to deliver products/services. To achieve the organizational effectiveness, proper utilization of the workplace has to be ensured. This course highlights the fundamental issues, concepts and the methodologies related to Plant layout and material handling.

Prerequisite

NIL

Course Outcomes

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

CO. No	Course Outcome	Bloom's level	Expected Proficiency %	Expected attainment %
CO 1.	Describe the facility location determinants and methods	Understand	80	90
CO 2.	Solve different types of facility location models	Apply	70	75
CO 3.	Design the layouts of manufacturing systems and service organizations	Apply	70	80
CO 4.	Prepare clusters of machine and components using clustering algorithms	Apply	70	80
CO 5.	Solve line balancing problems using heuristic algorithms.	Apply	70	70
CO 6.	Select an appropriate material handling system for manufacturing/ process industry applications	Apply	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO3.		M	M				M		M	M	M
CO4.	S	M	S	M	M		M		M		
CO5.	S	S	S		M		M		M		
CO6.	M	M	M		M				M	M	M
CO5.	S	S	S		M	M	M		M		
CO6.		M	M	M	M		S		M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	10	10	10	10
Understand	30	15	15	15
Apply	60	75	75	75
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List the issues of facility location.
2. Identify the factors to be considered for location selection.
3. Write the equation to compute the Euclidian distance.
4. Discuss about different types of facility location problem.

Course Outcome 2 (CO2):

1. The following table shows a matrix of travel times between possible locations for ambulance stations and areas in a city. Governing body's policy suggests that ambulance stations must be at most 30 minutes away from all population areas. Find the best locations for achieving this.

Possible Locations		I	II	III	IV	V	VI	VII
	A	5	11	20	33	27	36	33
	B	33	35	17	10	53	41	18
	C	18	39	41	12	33	22	37
	D	13	6	43	25	38	33	20
	E	35	47	41	45	50	51	43

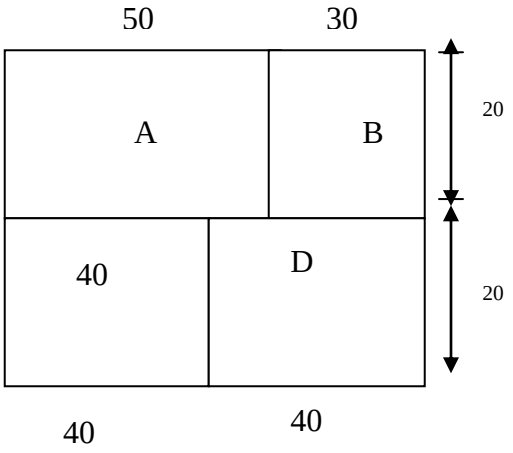
2. Discuss the various techniques of locating a single facility

Course Outcome 3 (CO3):

1. A company consists of the following functional areas. Design a layout using the construction algorithm ALDEP.

A – Wood cutting	1200 Sq. feet
B – Receiving	512
C – Framing	1280
D – Upholstery	1120
E – Fabric Storage	960
F – Fabric cutting	960
G- Sewing	640
H – Shipping	800
I – Offices	800
J – General Storage	480

2. The data for designing a layout are given below. Follow the steps of the CRAFT algorithm & develop a final CRAFT layout using the pair wise interchange technique. Use unit cost matrix. Initial Layout



-	A	B	C	D
A	-	2	4	4
B	1	-	1	3
C	2	1	-	2
D	4	1	0	-

Course Outcome 4 (CO4):

1. Identify the logical part families and machine groups by applying ROC technique. The part-machine incidence matrix is given in the table.

Parts / Machine	I	II	III	IV	V
1	1	0	0	0	0
2	0	1	0	0	1
3	1	0	0	1	0
4	0	1	1	0	0
5	0	0	0	1	0

2. Identify the logical part families and machine groups by applying ROC-2 technique. The part-machine incidence matrix is shown below.

Parts / Machine	I	II	III	IV	V
1	1	0	0	0	0
2	0	1	0	0	1
3	1	0	0	1	0
4	0	1	1	0	0
5	0	0	0	1	1

Course Outcome 5 (CO5):

1. A company produces 50 products per hour on its production line. The operations involved are given below. Balance the line for the given production rate using

Ranked positional weight method. Determine the workstations required and balance delay.

Work Element	Immediate Predecessor	Estimated time (Sec)
A	-	20
B	-	10
C	-	15
D	B,C	10
E	D	25
F	E	15
G	F	30
H	G	30
I	A,H	20
J	I	25

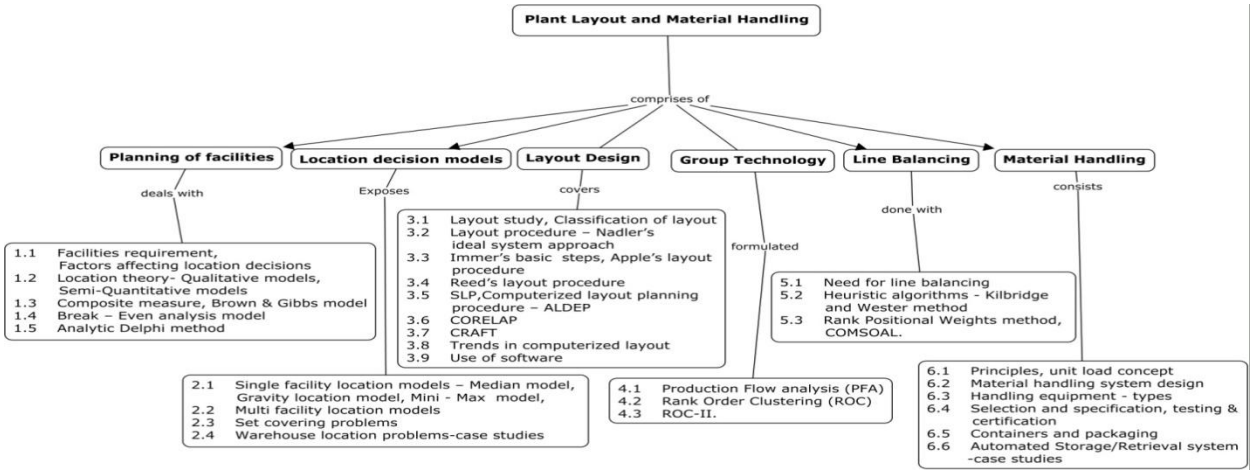
2. The operations involved in an organization are given below. Balance the line using Kilbridge and Wester method. Determine the balance delay. Assume that number of workstations is Three.

Work Element	Immediate Predecessor	Estimated time (Sec)
a	-	10
b	-	10
c	-	15
d	b,c	10
e	d	35
f	e	15
g	f	30
h	g	30
i	a,h	20
j	i	15

Course Outcome 6 (CO6):

1. Illustrate the basic material handling equipments and recommend the choice of MHEs for the chosen industrial scenario.
2. Design the Unit load system for your specific application system.
3. Choice of AS/AR system in comparison with the conventional warehousing system with example.
4. Choice of material handling system for a heavy manufacturing industry, express the pros and cons of the system under study.

Concept Map



Syllabus

Planning of facilities: Facilities requirement; Factors affecting location decisions , Location theory - Qualitative models , Semi-Quantitative models – Composite measure , Brown & Gibbs model , Break – Even analysis model; Analytic Delphi method.

Location decision models: Single facility location models– Median model, Gravity location model, Mini - Max model, Multi facility location models - Set covering problems – Warehouse location problems-case studies.

Layout design: Layout study - Classification of layout , Layout procedure – Nadler's ideal system approach, Immer's basic steps, Apple's layout procedure, Reed's layout procedure Systematic Layout planning (SLP), Computerized layout planning procedure – ALDEP, CORELAP, CRAFT; Trends in computerized layout and algorithm for Group Technology; Use of Software for layout modeling.

Group Technology: Production Flow analysis (PFA), Rank Order Clustering (ROC), ROC-II.

Line balancing: Need, Heuristic algorithms - Kilbridge and Wester method, Rank Positional Weights method (RPW), COMSOAL.

Material Handling: Principles, unit load concept, material handling system design; handling equipment - types, selection and specification, testing and certification; containers and packaging; Automated Storage/Retrieval system-case studies.

Reference Books / Learning resources

1. Tompkins, J.A. and White J.A., “Facilities planning”, Fourth Edition, John Wiley, 2010.
2. Richard Francis.L. and John A.White, “Facilities Layout and location - an analytical approach”, Prentice Hall of India, 2012.
3. James Apple, M, ”Plant layout and “Material Handling”, John Wiley, 1991. (No Reprint)
4. Pannerselvam, R, “Production and Operations Management”, Third Edition, Prentice Hall of India,2012.
5. Krajewski, J. and Ritzman, “Operations Management – Strategy and Analysis”, Addison – Wesley publishing company , 5th Edition, 1999
6. E-learning material- NPTEL videos at htps://nptel.ac.in/courses/112102106 by Prof. Arun Kanda, Dept of Mechanical Engineering, IIT, Delhi

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Planning of facilities**	
1.1	Facilities requirement, Factors affecting location decisions	1
1.2	Location theory- Qualitative models, Semi-Quantitative models	1
1.3	Composite measure, Brown & Gibbs model	2
1.4	Break – Even analysis model	2
1.5	Analytic Delphi method	1
2	**Location decision models**	
2.1	Single facility location models – Median model, Gravity location model, Mini - Max model,	1
2.2	Multi facility location models	1
2.3	Set covering problems	1
2.4	Warehouse location problems-case studies	1
3	**Layout design**	
3.1	Layout study, Classification of layout	1
3.2	Layout procedure – Nadler’s ideal system approach	2
3.3	Immer’s basic steps, Apple’s layout procedure	1
3.4	Reed’s layout procedure	1
3.5	SLP, Computerized layout planning procedure – ALDEP	2
3.6	CORELAP	1
3.7	CRAFT	2
3.8	Trends in computerized layout and algorithm for Group Technology	1
3.9	Use of Software for layout modeling	1
4	**Group Technology**	
4.1	Production Flow analysis (PFA)	1
4.2	Rank Order Clustering (ROC)	2

4.3	ROC-II.	1
5	**Line balancing**	
5.1	Need for line balancing	1
5.2	Heuristic algorithms - Kilbridge and Wester method	1
5.3	Rank Positional Weights method, COMSOAL.	2
6	**Material Handling**	
6.1	Principles, unit load concept	1
6.2	Material handling system design	2
6.3	Handling equipment - types	1
6.4	Equipment - Selection and specification, testing and certification	1
6.5	Containers and packaging	1
6.6	Automated Storage/Retrieval system-case studies	2
	Total	**40**

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		Category	L	T	P	Credit
18IEPM0	**ROBUST DESIGN**	PE	3	0	0	3

Preamble

Robust Design is a proven development philosophy focused on achieving target reliability. Approaching this aggressive goal requires that Robust Design principles be an early and integral part of the development cycle. Cost of Product performance Issues not only leads to erosion of profit, but also leads to loss of reputation and competitive advantage in Global economy. It is absolutely essential to understand the root cause of issues, either in Predictive Design of New Products or in Fixing Field issues of existing products or even enhancing the productivity in a Manufacturing environment. The objective is to make the end-product immune to factors that could adversely affect performance. A Robust Design flow is used to implement and analyze the design to ensure system reliability. The objective of Robust Design flow is to meet performance requirements with the highest possible system reliability and the most reasonable systems cost. Robust design saves considerable time and efforts in trouble shooting, identifying quality inputs and in rectifying the total system.

Prerequisite

- Applied Probability and Statistics

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Explain the concepts and terminology of robust design.	Understand	80	70
CO2.	Illustrate the different models of single factor experiments of robust design.	Understand	80	70
CO3.	Conduct experiments with various factors at different levels to solve using DoE Techniques.	Analyze / apply	70	60
CO4.	Solve the problems for different cases using confounding techniques.	Apply	70	60
CO5.	Examine the optimum operating conditions of process parameters using orthogonal array design	Analyze	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	L	L	M	M	M				L	L

CO2	L	L	L	M	M	M				L	L
CO3	M	S	S	M	M	M	S			M	M
CO4	M	S	S	S	S	M	S			M	M
CO5	S	S	S	S	S	M	S			M	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	60	30	10	10
Apply	20	40	40	40
Analyze	0	20	40	40
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Extend fixed effect model?
2. State the advantages of Confounding?
3. Explain about Random effect model?

Course Outcome 2 (CO2):

1. Describe the guidelines for designing experiments and elaborate the key points.
2. Briefly explain about the Blocking in experimental design with suitable examples.
3. State and explain the robust design concepts through quality Loss function.

Course Outcome 3 (CO3):

1. The compressive strength is being studied. Four different mixing techniques are being investigated. The following data have been collected.

Mixing Technique	Compressive strength			
1	313	300	287	289
2	320	330	298	315
3	280	290	299	305
4	260	270	260	277

a) Test the hypothesis that mixing us techniques affect the strength of the concrete. Use

α=0.5

b) Use Tukeys test to make comparisons between pairs of means.

Estimate the treatment effects.

2. A process engineer is trying to improve the life of a cutting tool. He has run a 2^3

experiment using cutting speed (A), metal hardness (B) and cutting angle (c) as the factors. The data from two replicates are shown here. (A) Do any of the factors affect tool life (b) What combination of factor levels produces the longest tool life? (C) C s there a combination of cutting speed and cutting angle that always gives good results regardless of metal hardness.

Run	Replicate	
	I	II
(1)	221	311
a	325	435
b	354	348
ab	552	472
C	440	453
Ac	406	377
Be	605	503
a be	392	419

3. A 2^3 design has been used to investigate the effect of four factors on the resistivity of a silicon wafer. The data from this experiment are shown here.

Run	A	B	B	D	Resistivity
1	-	-	·	·	33.2
2	+	-	·	+	4.6
3	-	+	-	+	31.2
4	+	+	·	-	9.6
5	-	-	+	+	162.4
6	+	-	+	-	39.4
7	-	+	+	-	158.6
8	+	+	+	+	40.6

a) Estimate the factor effects. Plot the effect estimates on a normal probability scale.

b) Plot the residuals from the model Vs the predicted resistivity. Is there any indication on this plot of model adequacy?

Course Outcome 4 (CO4):

1. An annealed copper strip 228 mm wide and 25 mm thick, is rolled to a thickness of 20 mm. The roll radius is 300 mm and rotates at 100 rpm. Calculate the roll force and the power in this operation.

2. A solid cylindrical work piece made of 304 stainless steel is 150 mm in diameter and 100 mm high. It is forged by open die forging at room temperature with flat dies to a 50 % reduction in height. Assuming that the coefficient of friction is 0.2, calculate the forging force at the end of the stroke.

3. A round billet made of 70-30 brass is extruded at a temperature of 675° C. The billet diameter is 125 mm and the diameter of the extrusion is 50 mm. Calculate the extrusion force required.

Course Outcome 5 (CO5):

1. An experiment to investigate the effect of glass type and phosphor type on the brightness of a television tube. The response measured is the current necessary in micro-amps to obtain a specified brightness level. The data are shown here. Analyze the data and draw conclusions.

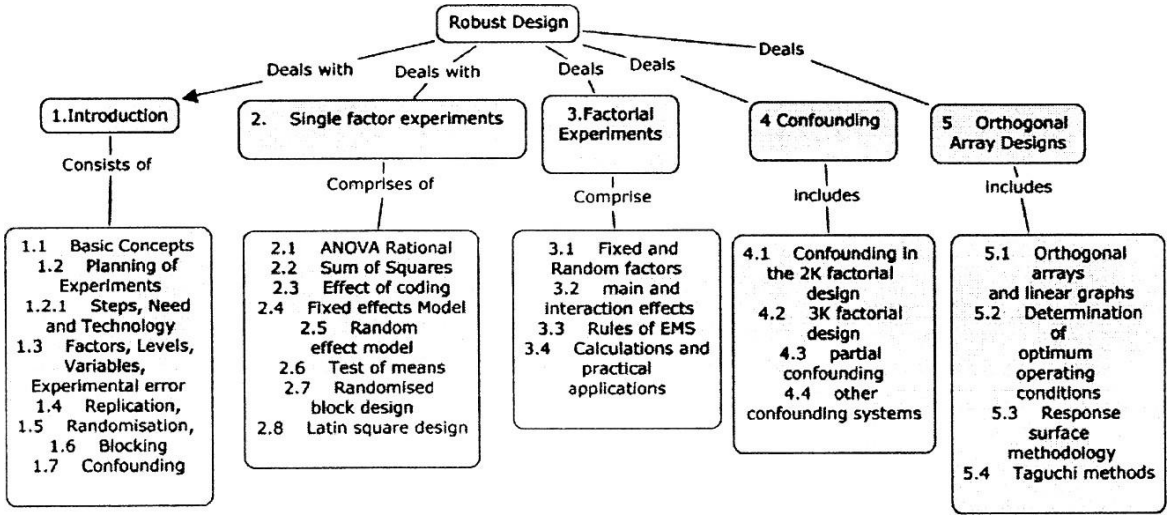
Glass Type	**Phosphor type**		
	1	**2**	**3**
1	280 290	300 310	290 285
2	230 235	260 240	220 225

2. An experiment was run using two factors. Gas flow rate (A) and deposition time (B). Four replicates were run and the epitaxial layer thickness was measured in (microns), The data are shown below.

A	B	Replicate			
		I	Ii	III	IV
.	.	14.03	16.16	13.97	13.9
+	+	13.88	13.86	14.03	13.91
.	+	14.82	14.75	14.84	14.87
+	+	14.88	14.92	14.41	14.93

Analyze this experiment assuming that each one of the four replicates represents a block.

Concept Map



Syllabus

Introduction: Basic Concepts - Planning of Experiments, Steps, Need, and Technology- Factors, Levels, Variables, Experimental error, Replication, Randomization, Blocking, and Confounding. **Single factor experiments:** ANOVA Rational, Sum of Squares, Effect of coding, Fixed effects Model, Random effect model - Test of means - Randomized block design - Latin square design. **Factorial Experiments:** Fixed and Random factors main and interaction effects, rules of EMS, calculations and practical applications - Fractional factorials **Confounding**: Confounding in the 2^K factorial design, 3^K factorial design, partial confounding other confounding systems. **Orthogonal Array Designs:** Orthogonal arrays and linear graphs, Determination of optimum operating conditions, Response surface methodology and Taguchi methods.

Reference Book / Learning Resources

1. Douglas C. Montgomery, "**Design and Analysis of Experiments**", Ninth Edition, John Wiley and Sons, New York, 2013.
2. Angela Dean and Daniel Voss," **Design and Analysis of Experiments**", First Indian reprint, Springer Internationaledition,2013
3. Philips J. Ross, "**Taguchi Techniques for Quality Engineering**", McGraw Hill,1995
4. N. Belavendran, **"Quality by Design"** Prentice Hall International, 1995.
5. MIT Open Courseware – **Robust System Design**. Instructor - Prof. Daniel Frey. URL: http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-881-robust-system-design-

summer-1998/

6. NPTEL Video Lectures – Applications to Robust Design. Prof. A. De. IIT Bombay URL:http://nptel.ac.in/courses/112101005/31

Course Contents and Lecture Schedule

Sl.No.	Topics	No. Of Periods
1.	**Introduction**	
1.1	Basic Concepts	1
1.2	Planning of Experiments	1
1.2.1	Steps, Need and Technology	1
1.3	Factors, Levels, Variables, Experimental error	1
1.4	Replication,	1
1.5	Randomization,	1
1.6	Blocking	1
1.7	Confounding	1
2.	**Single factor experiments**	
2.1	ANOVA Rational	1
2.2	Sum of Squares	1
2.3	Effect of coding	1
2.4	Fixed effects Model	1
2.5	Random effect model	1
2.6	Test of means	1
2.7	Randomized block design	1
2.8	Latin square design	1
3.	**Factorial Experiments**	
3.1	Fixed and Random factors	1
3.2	Main and interaction effects	1
3.3	Rules of EMS	1
3.4	Calculations and practical applications	2
3.5	Fractional Factorials	2
4	**Confounding**	
4.1	Confounding in the 2^K factorial design	2
4.2	3^k factorial design	2
5	**Orthogonal Array Designs**	

5.1	Orthogonal arrays and linear graphs	2
5.2	Determination of optimum operating conditions	2
5.3	Response surface methodology	2
5.4	Taguchi methods	2
	Total	**36**

Course Designers:

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2. S. Rajkumar srmech@tce.edu

		Category	L	T	P	Credit
18IEPP0	**SAFETY ENGINEERING**	PE	3	0	0	3

Preamble

Safety engineering is an engineering discipline which assures that engineered systems provide acceptable levels of safety. It is strongly related to industrial engineering/systems engineering, and the subset system safety engineering. This course is very much useful for improve the Green and clean Environmental aspect.

Prerequisite

- NIL

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Describe the concepts and techniques of Safety Engineering	Understand	80	70
CO2.	Identify the different hazards of occupational health in different Industries	Apply	70	70
CO3.	Explain the various Industrial safety Acts in National and International standards	Understand	80	70
CO4.	Suggest the possible techniques or methods to overcome the safety issues in different types of Industry	Apply	70	70
CO5.	Interpret the results of safety engineering in different industries with Environment pollution	Analyze	70	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	10	10
Understand	40	40	30	30

Apply	40	40	40	40
Analyse	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the basic concepts of Safety Engineering?
2. Explain the different techniques of Safety Engineering?
3. What is Safety Policy?
4. Describe the history of Safety Movement.
5. Explain the methods of Safety Inspection?

Course Outcome 2 (CO2):

1. Estimate the expected impacts of Occupational health and Industrial Hygiene.
2. Explain the Effects of the Physical Hazards in Occupational health and safety?
3. Classify the different hazards in different industries.

Course Outcome 3 (CO3):

1. Explain the Tamil Nadu Factories Rules 1950 under safety and health Chapters of factories Act 1948.
2. Explain the Occupational safety and Health act of USA.
3. Explain OSHAS 18000 standards.
4. Explain the Occupational safety and Health act of UK.
5. What is Penalties and Procedure for Industrial Safety?

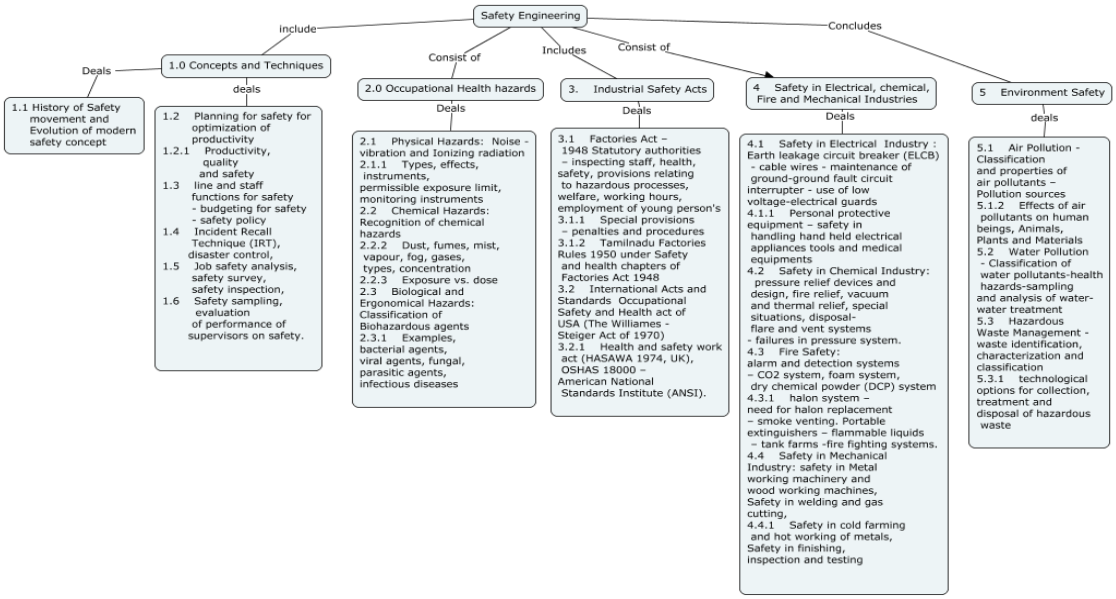
Course Outcome 4 (CO4):

1. Suggest the various Contributions of ergonomical factors to plant and operator safety.
2. Suggest the different preventing techniques to different types of Industry.
3. Implement any Modern tools and techniques for safety Engineering.
4. Identify the various methods to prevent the Fire Accident in various Industries.
5. Mention any modern tools are available to implement to avoid accident in Mechanical Industries.

Course Outcome 5 (CO5):

1. Analyze the possible causes of safety in different industries to avoid the pollution (Air pollution – Automobile Sector)
2. Analyze the possible causes of safety in different industries to avoid the pollution (Water pollution – Chemical Industry)
3. Analyze the possible causes of safety in different industries to avoid waste (e - waste and medical waste – Computer and Hospital Industry)

Concept Map



Syllabus

Concepts and Techniques: History of Safety movement –Evolution of modern safety concept - planning for safety for optimization of productivity -productivity, quality and safety - line and staff functions for safety - budgeting for safety - safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

Occupational Health hazards

Physical Hazards: Noise - vibration and Ionizing radiation - types, effects, instruments, permissible exposure limit, monitoring instruments. **Chemical Hazards:** Recognition of chemical hazards - dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose. **Biological Hazards** : Classification of Biohazardous agents – examples, bacterial agents, viral agents, fungal, parasitic agents, infectious diseases.

Industrial Safety Acts

Factories Act – 1948 Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young person's – special provisions – penalties and procedures - Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948. **International Acts and Standards** Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – American National Standards Institute (ANSI).

Safety in Electrical, chemical, Fire and Mechanical Industries

Safety in Electrical Industry : Earth leakage circuit breaker (ELCB) - cable wires - maintenance of ground-ground fault circuit interrupter - use of low voltage-electrical guards -

Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipments.

Safety in Chemical Industry: pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

Fire Safety: alarm and detection systems – CO2 system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms -fire fighting systems.

Safety in Mechanical Industry: safety in Metal working machinery and wood working machines, Safety in welding and gas cutting, Safety in cold farming and hot working of metals, Safety in finishing, inspection and testing.

Environment Safety

Air Pollution - Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials. **Water Pollution** - Classification of water pollutants-health hazards-sampling and analysis of water-water treatment. **Hazardous Waste Management -** waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste.

Reference Book / Learning Resources

1. Blake R.B., "**Industrial Safety**" Prentice Hall, Inc., New Jersey, 1973.
2. Dan Petersen, "**Techniques of Safety Management**", McGraw-Hill Company, Tokyo, 1981.
3. N.V. Krishnan **"Safety in Industry"** Jaico Publishery House, 1996.
4. John V. Grimaldi and Rollin H. Simonds, **"Safety Management"** by, All India Travelers Book seller, New Delhi, 1989
5. Danuta Koradecka, **Handbook of Occupational Health and Safety**, CRC, 2010.
6. Benjamin O.Alli, **Fundamental Principles of Occupational Health and Safety**, ILO 2008
7. **"Accident Prevention Manual"** – NSC, Chicago, 1982.
8. **"Occupational safety Manual"** BHEL, Trichy, 1988.
9. **The Factories Act 1948**, Madras Book Agency, Chennai, 2000
10. **The Environment Act (Protection) 1986**, Commercial Law Publishers (India) Pvt.Ltd, New Delhi.
11. Power Engineers – **Handbook of TNEB**, Chennai, 1989.
12. **Safety in the use of wood working machines**, HMSO, UK 1992.
13. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
14. Heinrich H.W. "**Industrial Accident Prevention**" McGraw-Hill Company, New York, 1980
15. G. T Miller, **Environmental Science: Working with the Earth**, 11th Edition, Wadsworth Publishing Co., Belmont, CA, 2006
16. M.J Hammer,., and M.J Hammer, **Water and Wastewater Technology**, Pearson Prentice Hall, 2006
17. https://onlinecourses.nptel.ac.in/noc18_mg42/preview, Prof. J. Maiti, Department of

Industrial and Systems Engineering, IIT Kharagpur.

Course Contents and Lecture Schedule

Sl.No.	Topics	No. Of Periods
1.	**Concepts and Techniques**	
1.1	History of Safety movement and Evolution of modern safety concept	1
1.2	Planning for safety for optimization of productivity	1
1.2.1	Productivity, quality and safety	1
1.3	line and staff functions for safety - budgeting for safety - safety policy	1
1.4	Incident Recall Technique (IRT), disaster control,	1
1.5	Job safety analysis, safety survey, safety inspection,	1
1.6	Safety sampling, evaluation of performance of supervisors on safety.	1
2.	**Occupational Health hazards**	
2.1	**Physical Hazards**: Noise - vibration and Ionizing radiation	1
2.1.1	Types, effects, instruments, permissible exposure limit, monitoring instruments	1
2.2	**Chemical Hazards:** Recognition of chemical hazards	1
2.2.2	Dust, fumes, mist, vapour, fog, gases, types, concentration	1
2.2.3	Exposure vs. dose	1
2.3	**Biological and Ergonomical Hazards**: Classification of Biohazardous agents	1
2.3.1	Examples, bacterial agents, viral agents, fungal, parasitic agents, infectious diseases	1
3.	**Industrial Safety Acts**	
3.1	**Factories Act** – 1948 Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young person's	2
3.1.1	Special provisions – penalties and procedures	1
3.1.2	Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948	1
3.2	**International Acts and Standards** Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970)	1
3.2.1	Health and safety work act (HASAWA 1974, UK), OSHAS 18000 – American National Standards Institute (ANSI).	1

4	**Safety in Electrical, chemical, Fire and Mechanical Industries**	
4.1	**Safety in Electrical Industry :** Earth leakage circuit breaker (ELCB) - cable wires - maintenance of ground-ground fault circuit interrupter - use of low voltage-electrical guards	1
4.1.1	Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipments	1
4.2	**Safety in Chemical Industry:** pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.	1
4.3	**Fire Safety:** alarm and detection systems – CO2 system, foam system, dry chemical powder (DCP) system	1
4.3.1	halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms -fire fighting systems.	1
4.4	**Safety in Mechanical Industry**: safety in Metal working machinery and wood working machines, Safety in welding and gas cutting,	2
4.4.1	Safety in cold farming and hot working of metals, Safety in finishing, inspection and testing	1
5	**Environment Safety**	
5.1	**Air Pollution** - Classification and properties of air pollutants – Pollution sources	2
5.1.2	Effects of air pollutants on human beings, Animals, Plants and Materials	2
5.2	**Water Pollution** - Classification of water pollutants-health hazards-sampling and analysis of water-water treatment	2
5.3	**Hazardous Waste Management -** waste identification, characterization and classification	1
5.3.1	technological options for collection, treatment and disposal of hazardous waste	1
	Total	**36**

Course Designers:

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		Category	L	T	P	Credit
18IEPQ0	**ENTREPRENEURSHIP DEVELOPMENT**	PE	3	0	0	3

Preamble

This course will give the students the foundational experience of the entire cycle of entrepreneurship, through a combination of theory and practice. Students will learn what it takes to be an entrepreneur, recognizing business opportunities and the basics to create, launch and manage new businesses.

Prerequisite

- NIL

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Identify the Skills required for Entrepreneurship Development Activities.	Apply	70	60
CO2.	Analyze the various opportunity to create a new startup.	Analyze	70	60
CO3.	Formulate a new idea to business model by market survey.	Analyze	70	60
CO4.	Prepare the business plan with Feasibility report and validate it.	Apply	70	60
CO5.	Describe the Government Policies and Regulations for business models.	Understand	80	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	10	10	10	10
Understand	20	20	20	20
Apply	40	40	40	40
Analyze	30	30	30	30
Evaluate	_	_	_	_
Create	_	_	_	_

Course Level Assessment Questions

Course Outcome 1 (CO1):

6. Distinguish between team skills and individual skills .
7. Explain the roles and responsibilities of a leader.
8. Explain the different types of collaboration tools to identify problems in a manufacturing sector.
9. Define Entrepreneurship.

Course Outcome 2 (CO2):

1. Assume an entrepreneur planning to start a finishing school for Engineering graduates. Identify Jobs to be done, Pain reliever and Gain creator of this idea. Sketch Value proposition canvas for the above idea.
2. Explain the difference between consumer and Customer with appropriate example.
3. Summarize the need for identifying customer personas in a business.
4. Examine the opportunities available to setup a textile business in a rural area and give inference to improve the business market.

Course Outcome 3 (CO3):

1. Outline the fundamentals of Design thinking process?
2. Explain Blue ocean strategy?
3. Describe the need for identifying and building a Minimum Viable prototype?
4. Survey the gold business market and provide key strategies to improve the market.

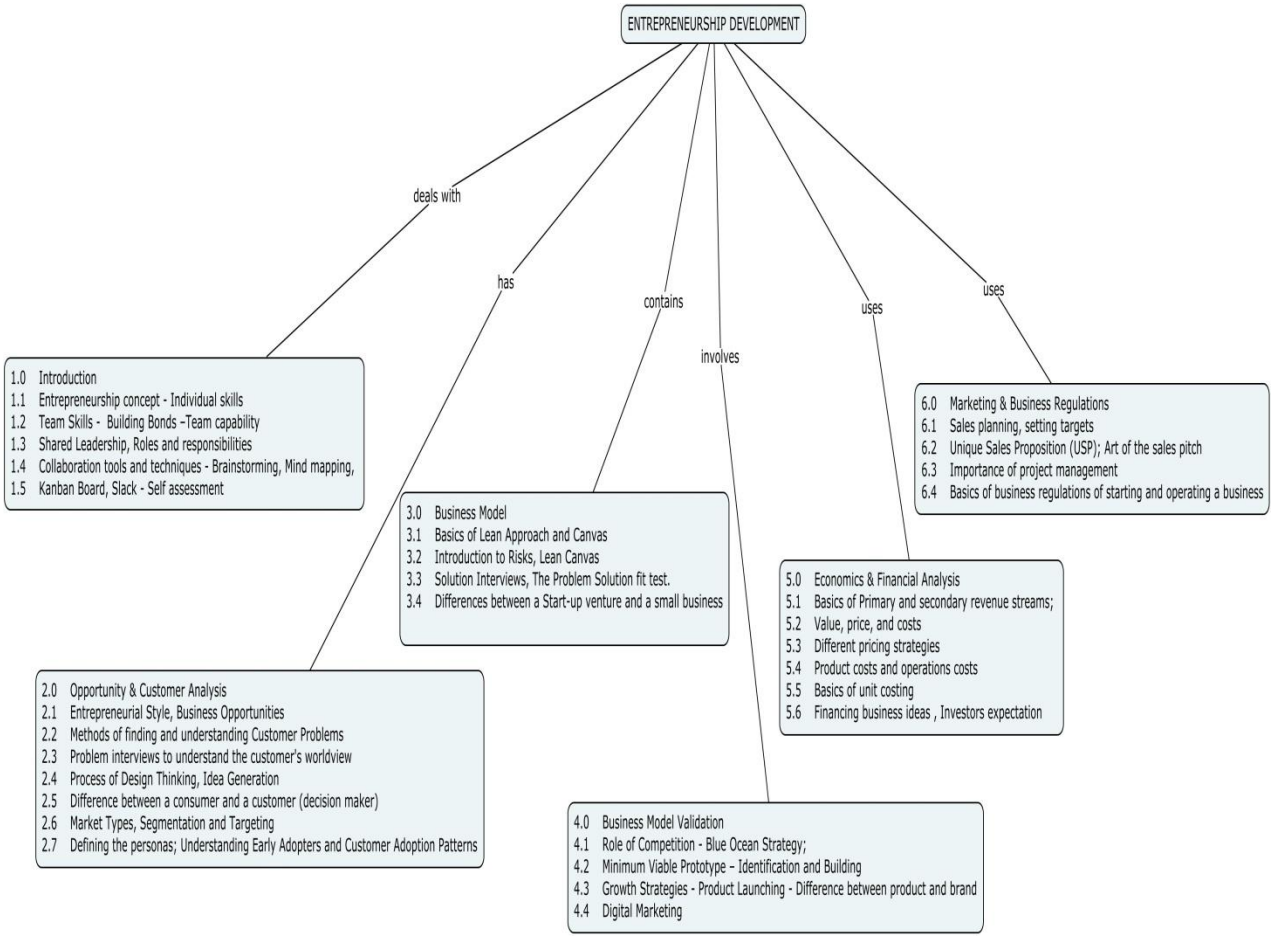
Course Outcome 4 (CO4)

1. An Entrepreneur wants to create an app for battery-operated, eco-friendly cab service in Madurai. Identify Key activities, Customer segment, Channels, Revenue stream, Unique Value Proposition for the above business and prepare a Business plan for the above case.
2. Present your views on merits of Lean canvas than a detailed business plan.
3. Summarize the merits of building a Minimum viable product when compared to fully functional product in the context of startup venture.
4. Distinguish between solution demo and Minimum Viable product?
5. Illustrate when a Minimum viable product can be considered as closer to product-market fit?

Course Outcome 5 (CO5)

1. Explain the differences between startup cost, fixed cost and variable cost. Identify which of the above costs should be restricted with valid reasons.
2. List down few types of revenues commonly applicable for startup ventures?
3. Describe three predominant pricing strategies that are adopted to fix the price of the product or service that address buyer's willingness to pay, and a seller's willingness to accept.
4. Explain the labor laws in business.
5. Explain the government regulations for Environmental pollution act.

Concept Map



Syllabus

Introduction: Entrepreneurship concept - Individual skills - Team Skills - Building Bonds – Team capability - Shared Leadership, Roles and responsibilities; Collaboration tools and techniques - Brainstorming, Mind mapping, Kanban Board, Slack; Self assessment.

Opportunity & Customer Analysis - Entrepreneurial Style; Business Opportunities, Methods of finding and understanding Customer Problems- problem interviews to understand the customer's worldview, Process of Design Thinking, Idea Generation; Difference between a

consumer and a customer (decision maker); Market Types, Segmentation and Targeting, Defining the personas; Understanding Early Adopters and Customer Adoption Patterns.

Business Model - Basics of Lean Approach and Canvas; Introduction to Risks; Lean Canvas; solution interviews; The problem-solution fit test; Differences between a Startup venture and a small business.

Business Model Validation

Role of Competition - Blue Ocean Strategy; Minimum Viable Prototype – Identification and Building - Growth Strategies - Product Launching - Difference between product and brand; Digital Marketing

Economics & Financial Analysis - Basics of primary and secondary revenue streams; Value, price, and costs; Different pricing strategies; Product costs and operations costs; Basics of unit costing; Financing business ideas; Investors expectation

Marketing & Business Regulations - Sales planning, setting targets; Unique Sales Proposition (USP); Art of the sales pitch; Importance of project management; Basics of business regulations of starting and operating a business - labor laws, tax codes, advertising laws, environmental acts.

Reference Books/ Learning Resources

1. Ash Maurya, **Running Lean**, 2nd Edition, O'Reilly Media, Inc., USA, 2012
2. Rajeev Roy, **Entrepreneurship**, 2nd Edition, Oxford University Press, 2011.
3. Hisrich, **'Entrepreneurship'**, Tata McGraw Hill, New Delhi, 2006.
4. S.S.Khanka, **'Entrepreneurial Development'**, S.Chand and Company Limited, New Delhi, 2001.
5. P. Saravanavel, **'Entrepreneurial Development'**, Ess Pee kay Publishing House, Chennai -1997.
6. Prasama Chandra, **'Projects – 'Planning, Analysis, Selection, Implementation and Reviews'**, Tata McGraw-Hill Publishing Company Limited 1996.
7. P.C. Jain (ed.), **'Handbook for New Entrepreneurs'**, EDII, Oxford University Press, New Delhi, 1999.
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11. Daniel Goleman, **"Working with Emotional Intelligence"** Bantam publishers, 2000.
12. Harvard Business Review, "**Entrepreneur's Hand book"**, March, 2018.
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Course Contents and Lecture Schedule

	Topic	No. of Hours
1.0	**Introduction**	
1.1	Entrepreneurship concept - Individual skills	1
1.2	Team Skills - Building Bonds –Team capability	1
1.3	Shared Leadership, Roles and responsibilities	1
1.4	Collaboration tools and techniques - Brainstorming, Mind mapping,	1
1.5	Kanban Board, Slack - Self assessment	2
2.0	**Opportunity & Customer Analysis**	
2.1	Entrepreneurial Style, Business Opportunities	1
2.2	Methods of finding and understanding Customer Problems	1
2.3	Problem interviews to understand the customer's worldview	1
2.4	Process of Design Thinking, Idea Generation	1
2.5	Difference between a consumer and a customer (decision maker)	1
2.6	Market Types, Segmentation and Targeting	2
2.7	Defining the personas; Understanding Early Adopters and Customer Adoption Patterns	2
3.0	**Business Model**	
3.1	Basics of Lean Approach and Canvas	1
3.2	Introduction to Risks, Lean Canvas	1
3.3	Solution Interviews, The Problem Solution fit test.	2
3.4	Differences between a Start-up venture and a small business	1
4.0	**Business Model Validation**	
4.1	Role of Competition - Blue Ocean Strategy;	1
4.2	Minimum Viable Prototype – Identification and Building	1
4.3	Growth Strategies - Product Launching - Difference between product and brand	2
4.4	Digital Marketing	1
5.0	**Economics & Financial Analysis**	
5.1	Basics of Primary and secondary revenue streams;	1
5.2	Value, price, and costs	1

	Topic	No. of Hours
5.3	Different pricing strategies	1
5.4	Product costs and operations costs	1
5.5	Basics of unit costing	1
5.6	Financing business ideas , Investors expectation	1
6.0	**Marketing & Business Regulations**	
6.1	Sales planning, setting targets	1
6.2	Unique Sales Proposition (USP); Art of the sales pitch	2
6.3	Importance of project management	1
6.4	Basics of business regulations of starting and operating a business - labor laws, tax codes, advertising laws, environmental acts.	1
Total number of Hours		**36**

Course Designers:

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		Category	L	T	P	Credit
18IEPR0	**HUMAN RESOURCE MANAGEMENT**	PE	3	0	0	3

Preamble

Human resource management is the strategic approach to the effective management of organization workers so that they help the business gain a competitive advantage. The human resources suggest how to strategically manage people as business resources, the responsibilities of a human resource manager fall into three major areas: staffing, employee compensation and benefits, and defining/designing work.. This includes managing recruiting and hiring employees, and suggesting employee training and development strategies.

Prerequisite

- NIL

Course Outcomes

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

CO.No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1.	Understand the basic concepts and Evolution of HRM.	Understand	80	70
CO2.	Understand the various concept of Human resource Planning.	Understand	80	70
CO3	Select the appropriate techniques used in Training and development.	Apply	80	70
CO4	Apply Sustainable practice used in HRM environment.	Apply	70	50
CO5	Design a HRM model for organization environment.	Apply	70	50

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	20	20	20	40
Apply	20	20	20	40

Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define HRM.
2. List the major activities in Human resource management.
3. Discuss the role of human factor in management process

Course Outcome 2 (CO2):

1. Enumerate the importance of Human resource Planning.
2. Explain about the sources of Recruitment.
3. Describe the advantages of job rotation.

Course Outcome 3 (CO3):

1. Discuss the need for training in modern industry.
2. Discuss the methods and types of training in detail
3. Evaluate the training programme with suitable example.

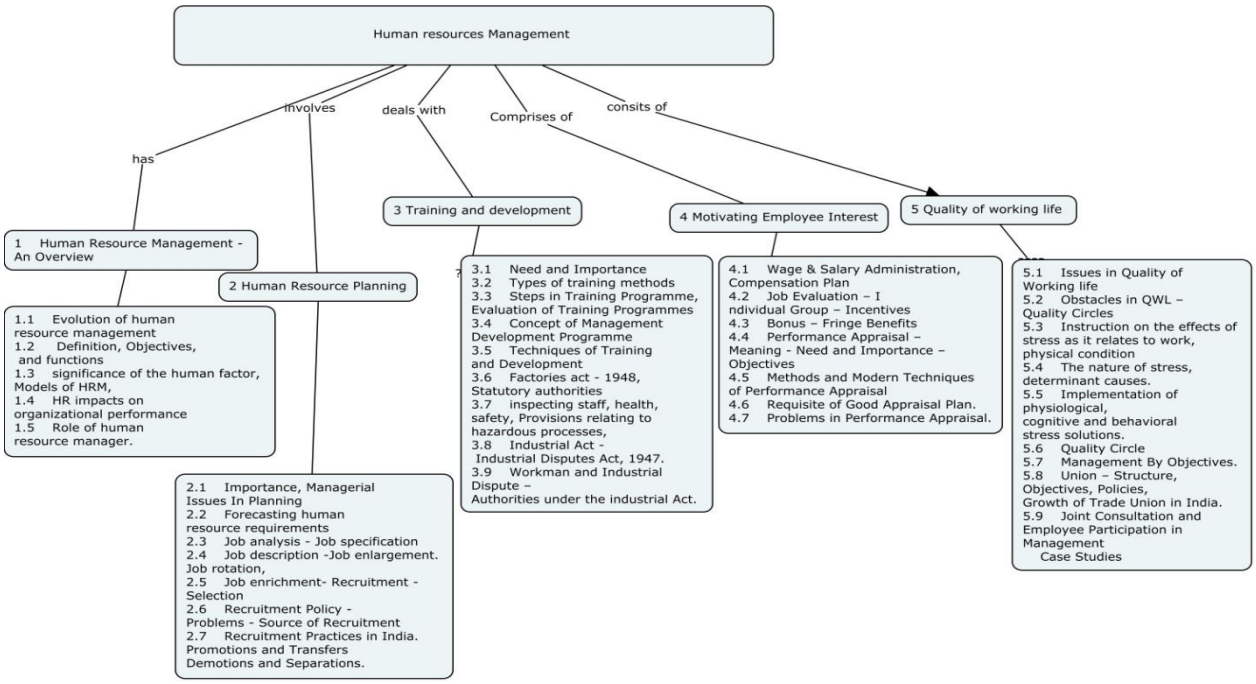
Course Outcome4 (CO4):

1. Construct the Compensation Plan for newly developed Company
2. Develop Appraisal Plan for IT industry.
3. Apply Modern methods of performance appraisal in to Small Scale industry

Course Outcome 5 (CO5):

1. Construct labor welfare Scheme in an organization.
2. Develop a structure for Employee Participation in Management to attain Organization goals.
3. Experiment with various methods for the determination of a collective Bargaining agent

Concept Map



Syllabus

HRM - Evolution of human resource management ,Definition, Objectives, and functions significance of the human factor – Models of HRM, HR impacts on organizational performance , Role of human resource manager.

Human Resource Planning – Importance, Managerial Issues In Planning- Forecasting human resource requirements. Job analysis - Job specification Job description -Job enlargement. Job rotation, Job enrichment- Recruitment - Selection – Recruitment Policy - Problems - Source of Recruitment – Recruitment Practices in India. Promotions and Transfers – Demotions and Separations.

Training and development - Need and Importance -Types of training methods – Steps in Training Programme – Evaluation of Training Programmes – Concept of Management Development Programme – Techniques of Training and Development- Factories act - 1948 Statutory authorities- inspecting staff, health, safety, Provisions relating to hazardous processes, Industrial Act - Industrial Disputes Act, 1947. Workman and Industrial Dispute – Authorities under the industrial Act.

Motivating Employee Interest - Wage & Salary Administration: Compensation Plan – Job Evaluation – Individual Group – Incentives – Bonus – Fringe Benefits – Performance Appraisal – Meaning - Need and Importance – Objectives – Methods and Modern Techniques of Performance Appraisal – Requisite of Good Appraisal Plan – Problems in Performance Appraisal.

Quality of working life - Issues in Quality of Working life – Obstacles in QWL. Instruction on the effects of stress as it relates to work, physical condition, The nature of stress, determinant causes, Implementation of physiological, cognitive and behavioral stress solutions. Quality Circle. Management By Objectives. Trade Union – Structure, Objectives, Policies, Growth of Trade Union in India – Joint Consultation and Employee Participation in Management - Case Studies.

Reference Book

1. Decenzo and Robbins, Human Resource Management, Wiley, 11th Edition, 2013.
2. Dessler, Human Resource Management, Pearson Education Limited,13th edition, 2007
3. Mamoria C.B. and Mamoria S. Personnel Management, Himalaya Publishing Company, 5th edition, 2011
4. Bernadin , Human Resource Management ,Tata Mcgraw Hill ,6th edition 2012.
5. Eugence Mckenna and Nic Beach, Human Resource Management, Pearson Education Limited,2nd edition, 2008
6. Ivancevich, Human Resource Management, McGraw Hill, 7th edition, 2010.
7. https://nptel.ac.in/courses/110105069/

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
1	**Human Resource Management - An Overview**	1
1.1	Evolution of human resource management	1
1.2	Definition, Objectives, and functions	1
1.3	significance of the human factor, Models of HRM,	1
1.4	HR impacts on organizational performance	1
1.5	Role of human resource manager.	1
2	**Human Resource Planning**	
2.1	Importance, Managerial Issues In Planning	1
2.2	Forecasting human resource requirements	1
2.3	Job analysis - Job specification	1
2.4	Job description -Job enlargement. Job rotation,	1
2.5	Job enrichment- Recruitment - Selection	1
2.6	Recruitment Policy - Problems - Source of Recruitment	1
2.7	Recruitment Practices in India. Promotions and Transfers Demotions and Separations.	1
3.	**Training and development**	
3.1	Need and Importance	1
3.2	Types of training methods	1
3.3	Steps in Training Programme, Evaluation of Training Programmes	1
3.4	Concept of Management Development Programme	1
3.5	Techniques of Training and Development	1
3.6	Factories act - 1948, Statutory authorities	1
3.7	inspecting staff, health, safety, Provisions relating to hazardous processes,	1
3.8	Industrial Act - Industrial Disputes Act, 1947.	1
3.9	Workman and Industrial Dispute – Authorities under the industrial Act.	1
4	**Motivating Employee Interest**	
4.1	Wage & Salary Administration, Compensation Plan	1
4.2	Job Evaluation – Individual Group – Incentives	1
4.3	Bonus – Fringe Benefits	1
4.4	Performance Appraisal – Meaning - Need and Importance – Objectives –	1
4.5	Methods and Modern Techniques of Performance Appraisal	1
4.6	Requisite of Good Appraisal Plan.	1
4.7	Problems in Performance Appraisal.	1
5	**Quality of working life**	
5.1	Issues in Quality of Working life	1
5.2	Obstacles in QWL – Quality Circles	1

Module Number	Topic	No. of Lectures
5.3	Instruction on the effects of stress as it relates to work, physical condition	1
5.4	The nature of stress, determinant causes.	1
5.5	Implementation of physiological, cognitive and behavioral stress solutions.	1
5.6	Quality Circle	1
5.7	Management By Objectives.	1
5.8	Union – Structure, Objectives, Policies, Growth of Trade Union in India.	1
5.9	Joint Consultation and Employee Participation in Management	1
	Case Studies	2
	Total	**39**

Course Designers

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		Category	L	T	P	Credit
18IEPS0	**PROJECT MANAGEMENT**	PE	3	0	0	3

Preamble

Project management encompasses the basic concepts in the formulation of a project, principles, importance and need for network techniques and its applications.

Prerequisite

NIL

Course Outcomes

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

CO. No	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO 1.	Explain project, project management, life cycle and project formulation	Understand	80	90
CO 2.	Prepare project plan through Gantt chart.	Apply	70	75
CO 3.	Analyze the project plans through CPM and PERT	Analyze	60	70
CO 4.	Use resource smoothing and leveling technique for project management	Apply	70	80
CO 5.	Optimize resources of projects using scheduling, fast tracking and re- estimation Techniques	Analyze	60	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

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

Create	0	0	0	0

Course Outcome 1 (CO1):

1. Define project and project management. Mention its need.
2. Discuss the functions of project management.
3. Discuss the life cycle of projects with influencing factors.

Course Outcome 2 (CO2):

1. Differentiate between CPM and PERT
2. A project consists of six activities with the following logical relationships. Draw a network for the project and determine the critical path using traditional method

   - A and B are initial activities and can be performed concurrently
   - C follows A but cannot start until B is over
   - D and E succeed B
   - C and D precede F
   - E and F are terminal activities

Activity	**A**	**B**	**C**	**D**	**E**	**F**
Duration (Days)	7	8	3	2	7	4

   Find the status of the project on the 10th day of its commencement.

3. Conduct Event oriented network analysis for the following project and determine: - Earliest and latest allowable occurrence times for the events - Expected time and standard deviations for activities - Project completion time and its degree of variability - What is the probability of completing the project 2 days ahead of schedule? - What is the probability of not completing the project 1 day behind schedule? - Find the due date that has 75% chance of being met?

Activity(i-j)	**1-2**	**1-3**	**2-4**	**3-4**	**3-5**	**4-5**	**5-6**
t_0 (Days)	2	3	4	0	7	2	4
t_m (Days)	3	3	10	0	12	7	6
t_p (Days)	5	3	12	0	15	9	8

Course Outcome 3 (CO3)

1. Write the need for balancing of resources in project? Mention its significance

2. For an automobile industry project you as a project manager is vested with the responsibility of balancing manpower requirement, which method would you adopt for this process. Justify your answer with suitable reasons.
3. Balance the resource demand for the following project so as to meet the availability of 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**
Durations (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)

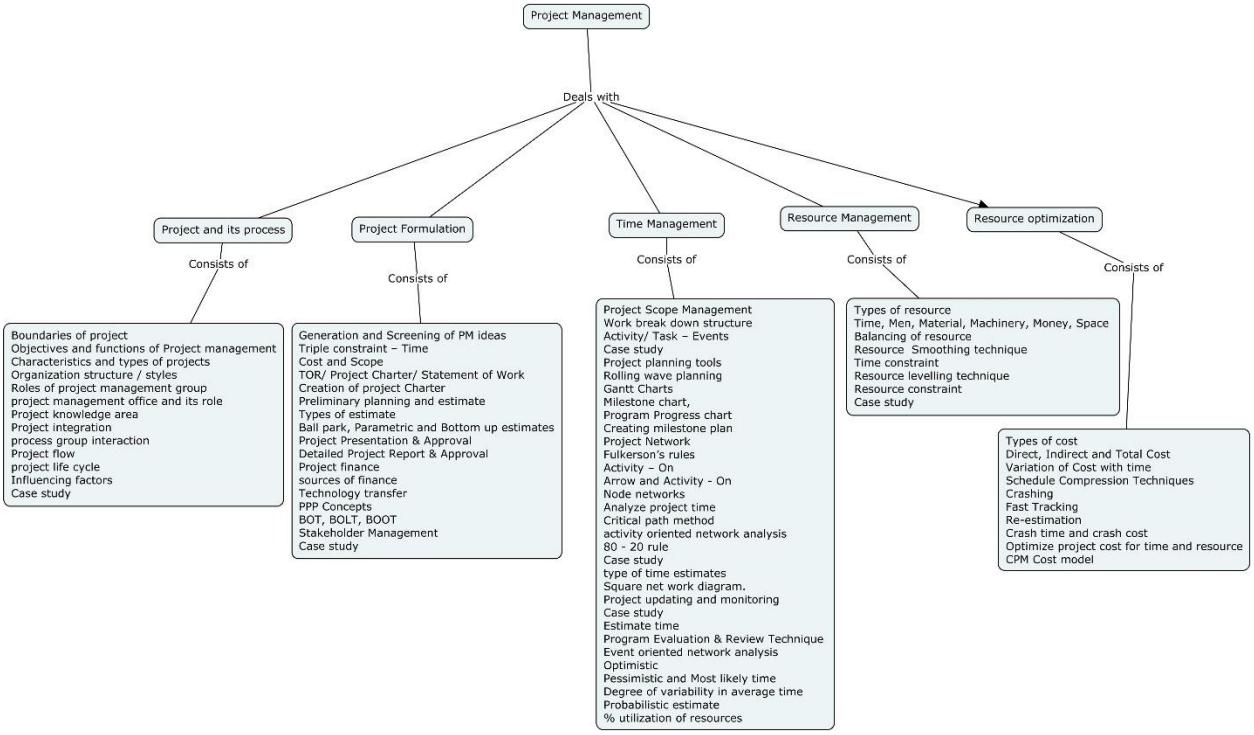
1. Define the term direct cost in projects with examples
2. Write the need and meaning of fast tracking and estimation of projects
3. A project consists of 7 activities with costs and times gives as shown in table. Crash the project and determine the optimum time and minimum cost relationship for the project. Assume the indirect cost to vary at Rs.500/- per day.

Activity (i-j)	**1-2**	**1-3**	**2-4**	**3-4**	**3-5**	**4-5**	**5-6**
Normal time days	5	7	4	2	5	3	4
Crash time days	3	4	2	1	3	2	1
Normal cost Rs.	500	100	200	400	350	380	50
Crash cost Rs.	800	300	500	750	800	900	150

Course Outcome 5(CO5)

1. List the benefits and limitations of latest tools in project management
2. Discuss why effective communication is needed for the success of anyprojects taking an example
3. Take of project of your choice in a mechanical industry and list and discussthe risks in the project along with possible methods of its mitigation.

Concept Map



Syllabus

Project and its process: Define project and process, boundaries of project, Objectives and functions of Project management, characteristics and types of projects, organization structure / styles, 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.

Project Formulation: Generation and Screening of PM ideas - Triple constraint – Time, Cost and Scope. TOR/ Project Charter/ Statement of Work (SOW) - Creation of project Charter. Preliminary planning and estimate - Types of estimate - Ball park, Parametric and Bottom up estimates. Project Presentation & Approval –Detailed Project Report & Approval (Technical and Budget Sanction), Project finance - sources of finance. Technology transfer - PPP Concepts, BOT, BOLT, BOOT. Stakeholder Management - Case study.

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 - Creating milestone plan. Project Network - Fulkerson's rules – Activity – On-Arrow and Activity - On-Node networks. Analyze project time - Critical path method (deterministic approach - activity oriented network analysis – 80 - 20 rule - Case study, type of time estimates & Square net work 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 levelling technique - Resource constraint - Case study. Agile management.

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.

Reference Books

7. Jerome D. Wiest and Ferdinand K. Levy, “A Management Guide to PERT/CPM”, Prentice Hall of India Publishers Ltd., New Delhi, 1994.
8. Srinath L.S., “PERT & CPM -Principles and Applications”, Affiliated East West Press Pvt., Ltd., New Delhi, 2008
9. A Risk Management Standard, AIRMIC Publishers, ALARM, IRM: 2002.
10. Gene Dixon, “Service Learning and Integrated Collaborative Project Management”, Project management Journal, DOI:10.1002/pmi, February 2011, pp.42 - 58
11. A Guide to the Project Management Body of Knowledge (PMBOK Guide) -Fifth Edition An American National Standard, ANSI/PMI 990001 -2008"
12. NPTEL videos at nptel.ac.in/courses/112102106 by Prof. Arun Kanda, Dept of Mechanical Engineering, IIT, Delhi

Course Contents and Lecture Schedule

Sl.No.	Topics	No. of Periods
1.0	**Project and its process**	
1.1	Define project and process, boundaries of project	1
1.2	Objectives and functions of Project management	1
1.3	Characteristics and types of projects	1
1.4	Organization structure / styles, roles of project management group	1
1.5	Project management office and its role, project knowledge area	1
1.6	Project integration -process group interaction.	1
1.7	Project flow, project life cycle - influencing factors - Case study.	2
2.0	**Project Formulation**	
2.1	Generation and Screening of PM ideas- Triple constraint – Time, Cost and Scope	1
2.2	TOR/ Project Charter/ Statement of Work (SOW) - Creation of project Charter	1
2.3	Preliminary planning and estimate - Types of estimate - Ball park, Parametric and Bottom up estimates	1
2.4	Project Presentation & Approval – Detailed Project Report & Approval (Technical and Budget Sanction)	2
2.5	Project finance - sources of finance	1
2.6	Technology transfer - PPP Concepts, BOT, BOLT, BOOT	1
2.7	Stakeholder Management - Case study.	2
3.0	**Time Management**	
3.1	Project Scope Management -Work breakdown structure - Activity/	2

	Task – Events - Case study.	
3.2	Project planning tools - Rolling wave planning. Gantt Charts, Milestone chart, Program Progress chart - Creating milestone plan	2
3.3	Project Network - Fulkerson's rules – Activity – On - Arrow and Activity - On - Node networks	1
3.4	Analyze project time - Critical path method (deterministic approach - activity oriented network analysis – 80 - 20 rule - Case study	2
3.5	Type of time estimates & Square net work diagram, Project updating and monitoring - Case study.	2
3.6	Estimate time - Program Evaluation & Review Technique (Probabilistic Approach)	1
3.7	Event oriented network analysis - Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources.	2
4.0	**Resource Management**	
4.1	Types of resource - Time, Men, Material, Machinery, Money, Space	1
4.2	Balancing of resource - Resource Smoothing technique - Time constraint	1
4.3	Resource leveling technique - Resource constraint - Case study. Agile management.	2
5.0	**Resource optimization**	
5.1	Types of cost –Direct, Indirect and Total Cost. Variation of Cost with time	1
5.2	Schedule Compression Techniques -Crashing, Fast Tracking & Re-estimation-Crash time and crash cost.	2
5.3	Optimize project cost for time and resource.CPM Cost model	2
	Total	**38**

Course Designers:

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18MGGA0 MULTI-OBJECTIVE OPTIMIZATION

Category	L	T	P	Credit
OE	2	0	0	2

Preamble

Optimization techniques are aimed to determine and evaluate the best possible feasible solutions. Most of the researches in the domain of optimization address single objective, multi-variable problems. However, real-world problems need to satisfy more than one objective thereto conflicting objectives and hence, there will not be an optimal solution. Various optimization methods have been proposed to obtain set of trade-off solutions for multi-objective optimization problems. This course aims to provide awareness over contemporary multi-objective optimization techniques for bi-objective optimization problems which will also augment the multi-objective evolutionary computation in addressing complex real-world problems.

Prerequisite

- Nil

Course Outcomes

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

CO. No.	Course Outcome	Bloom's Level	Expected Proficiency (%)	Expected attainment level (%)
CO1	Solve single objective unconstrained and constrained Non-Linear Programming Problems (NLPP) using appropriate techniques.	Apply	70	60
CO2	Solve bi-objective constrained Non-Linear Programming Problems (NLPP) using Utility Function Method and Bounded Objective Function Method.	Apply	70	60
CO3	Construct pareto-front for bi-objective optimization problems with Max-Max, Max-Min, Min-Max and Min-min optimality	Apply	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	L	L	M					M		
CO2	M	L	L	M					M		
CO3	M	L	L	M					M		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	10
Understand	20	20	20	30

Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. Implement golden section search technique to maximize $f(x) = 2x - 4x^2$, desired with final interval of uncertainty having a length less than of 0.05. Use the initial range as [0, 1] in which optimum lies.
2. Solve the following Non linear Programming Problem (NLPP),

   $Minimize \quad f(x) = x_1^{\,2} + x_2^{\,2} + x_3^{\,2}$

   Subject to constraints,

   $x_1 + x_2 + 3x_3 = 2$

   $5x_1 + 2x_2 + x_3 = 5$
3. Solve the following NLP: $Minimise \quad Z = x_1^{\,2} + x_2^{\,2}$

   Subject to $x_1 + 2x_2 \le 15$

   $1 \le x_i \le 10 \qquad i = 1,2$

Course Outcome 2 (CO2)**:**

1. Explain the classification of multi-objective optimization problems.
2. Solve the bi-objective optimization problem

   $f_1(x) = x^2$; $f_2(x) = (x-2)^2$; $x \in [0,2]$;

   Variable bounds = [-10^3, 10^3];
3. Solve the bi-objective optimization problem

   $f_1(x,y) = x$; $f_2(x,y) = (1+y)exp\left(\frac{-x}{1+y}\right)$;

   $g_1(x,y) = y + 9x \ge 6$; $\qquad g_2(x,y) = -y + 9x \ge 1$

   $x \in [0.1,1]$; y$\in [0,5]$;

Course Outcome 3 (CO3)**:**

1. Discuss the influence of divergence on the quality of pareto-optimal solutions.
2. Construct a pareto-front for the given set of solutions
3. Construct a pareto-front for the given set of solutions

$f_1(x)$	1.5	2.8	5.2	6.9	7.8	10.2
$f_1(x)$	5.0	3.5	6.2	5.5	6.8	9.3

4. Examine the following solutions in figure 1 and establish relation between them.

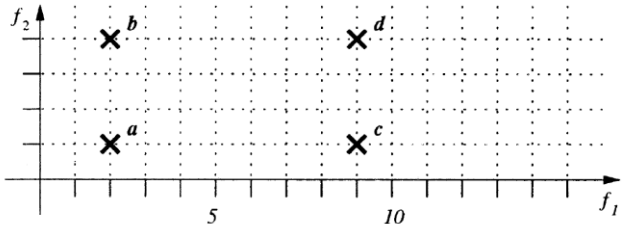
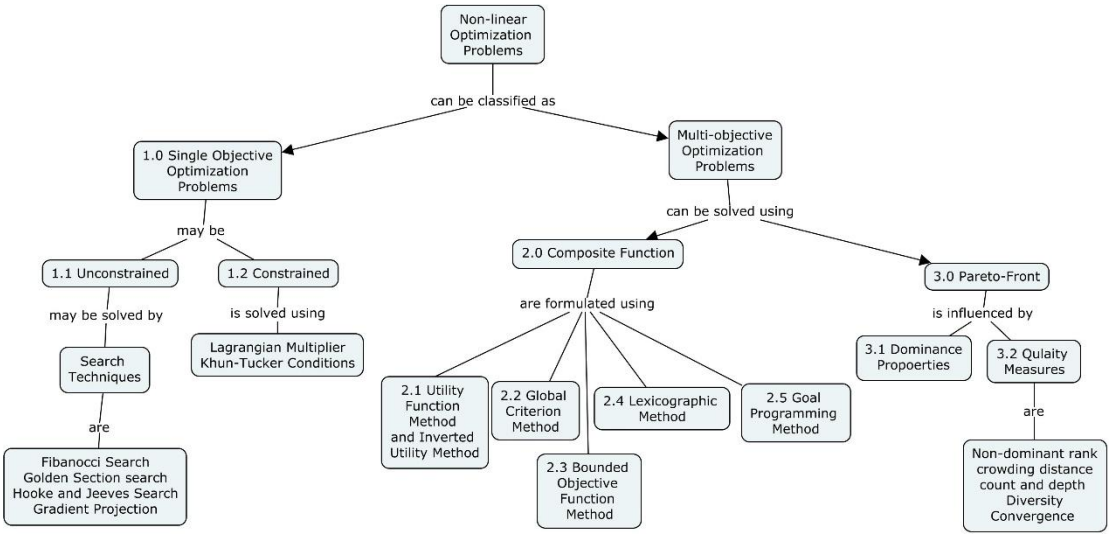


Figure 1

Concept Map



Syllabus

Nonlinear Programming Problems

Nonlinear Programming (Unconstrained Problem) - Basic Concepts - Classification– Fibanocci and Golden Section search - Hooks and Jeeves search - Gradient Projection – Nonlinear Programming (with Equality Constraints) Lagrangian Multiplier - Equality constrained optimization; Nonlinear Programming (Inequality Constraints): Khun concept - Khun Tucker conditions;

Multi-objective optimization methods - Utility Function Method, Inverted Utility Method, Global Criterion Method, Bounded Objective Function Method, Lexicographic Method and Goal Programming Method. Quantitative analysis of bi-objective optimization problems using Utility Function Method and Bounded Objective Function Method.

Pareto-Front – Terminologies – Dominance properties – Utility dominance, Stochastic dominance, Mean-variance dominance and Probability dominance; Quality measures – Non-dominant rank and crowding distance, count and depth - Diversity, Convergence. Pareto optimality: Bi-objective optimization problems with Max-Max, Max-Min, Min-Max and Min-min optimality.

Reference Books / Learning Resources

1. Kalyanmoy Deb, “Optimisation for Engineering Design – Algorithms and Examples”,2nd Edition, Eastern Economy Edition, PHI Learning Pvt. Limited, New Delhi, 2012.
2. Singiresu S.Rao, “Engineering Optimization”, 3rd Edition, New Age International Publishers, New Delhi, 2010.
3. Zitzler, E., Thiele, L., Laumanns, M., Fonseca, C.M. and Fonseca, V.G. “Performance assessment of multiobjective optimizers: an analysis and review”, IEEE Trans. Evlout. Comput., Vol. 7, No. 2, pp. 117-132, 2003.
4. Kalyanmoy Deb, Amrit Pratap, Sameer Agarwal, and T. Meyarivan, “A Fast and Elitist Multiobjective Genetic Algorithm:NSGA-II”, IEEE Transactions On Evolutionary Computation, Vol. 6, No. 2, pp.182-197, April 2002.

Course Contents and Lecture Schedule

Module Number	Topic	No. of Lectures
	Introduction to Optimisation techniques – Classification	1
1.0	**Single Objective Nonlinear Programming Problems**	1
1.1	Basic Concepts – Classification – Search Techniques	1
1.1.1	Nonlinear Programming (Unconstrained Problem) :Fibanocci and Golden Section search	2
1.1.2	Hooks and Jeeves search	1
1.1.3	Gradient Projection	1
1.2	Nonlinear Programming (with Equality Constraints) Lagrangian Multiplier – Equality constrained optimization;	1
1.3	Nonlinear Programming (Inequality Constraints): Khun concept – Khun Tucker conditions;	2
2.0	**Multi-objective optimization methods** – Introduction	1
2.1	Utility Function Method and Inverted Utility Method	1
2.2	Bounded Objective Function Method	2
2.3	Global Criterion Method	2
2.4	Lexicographic Method	1
2.5	Goal Programming Method	3
3.0	**Pareto-Front**	
3.1	Terminologies and Dominance properties	1
3.1.1	Utility dominance, Stochastic dominance, Mean-variance dominance and Probability dominance.	1
3.2	Quality measures – Non-dominant rank and crowding distance, count and depth – Diversity, Convergence.	1
3.3	Bi-objective optimization problems with Max-Max, Max-Min, Min-Max and Min-min optimality	2
Total		**25**

Course Designers:

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18PG250	RESEARCH METHODOLOGY AND IPR

Category	L	T	P	Credit
CC	2	0	0	2

Preamble

The course on the Research Methodology and IPR is offered as common Core course. The objective of this course is to understand and analyze Research Methodology and IPR protection.

Prerequisite

NIL

Course Outcomes

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R&D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Assessment Pattern

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

Syllabus

Module 1: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Module 2: Effective literature studies approaches, analysis Plagiarism, Research ethics

Module 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Module 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Module 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" 2nd Edition,
2. "Research Methodology: A Step by Step Guide for beginners"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Designers:

1. Adapted from AICTE Model Curriculum for Postgraduate Degree Courses in Engineering & Technology, Volume-I, January 2018.

18PGAA0	PROFESSIONAL AUTHORING

Category	L	T	P	Credit
AC	2	0	0	2

Preamble

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

1. Explain how to improve your writing skills and level of readability
2. Write each section of research paper
3. Write good quality technical paper

Syllabus

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills for writing a Title, writing an Abstract, writing an Introduction, writing a Review of the Literature,

Skills for Writing the Methods, Results, Discussion and Conclusions
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Assessment Pattern

Abstract	:	10
Introduction	:	10
Literature Review	:	10
Research Question	:	10
Methods	:	10
Results and Discussion	:	10
Conclusions	:	10
Appropriateness of Title	:	05
Quality of the Paper and Plagiarism	:	25

References

1. Goldbort R, 'Writing for Science', Yale University Press, 2006
2. Day R, 'How to Write and Publish a Scientific Paper', Cambridge University Press, 2006
3. Highman N, 'Handbook of Writing for the Mathematical Sciences, SIAM Highman's book, 1998
4. Adrian Wallwork, 'English for Writing Research Papers', Springer New York Dordrecht Heidelberg London, 2011

18PGAB0	VALUE EDUCATION

Category	L	T	P	Credit
AC	2	0	0	2

Preamble

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

1. Experience self-development
2. Explain the importance of Human values
3. Develop the overall personality

Syllabus

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles, Value judgements

Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

Personality and Behavior Development, Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth.
Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature
Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence , Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively

Assessment Pattern

Bloom's Category	Continuous Assessment Test	Terminal Examination
Remember	20	20
Understand	40	40
Apply	40	40
Analyse	0	0
Evaluate	0	0
Create	0	0

References

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", OxforUniversity Press, New Delhi