INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MASTER OF BUSINESS ADMINISTRATION

TUTORIAL QUESTION BANK

Course Name	:	QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS
Course Code	:	CMB011
Class	:	MBA III Semester
Branch	:	MBA
Academic Year	:	2018– 2019
Course Coordinator	:	Ms. I Shireesha, Associate Professor, MBA
Course Faculty	:	Ms. I Shireesha, Associate Professor, MBA

COURSE OBJECTIVES;

The course should enable the students to:

I	**Apply** quantitative techniques to business decisions using Mathematical tools.
II	**Develop** fundamental applications of those tools in industry and public sector in contexts involving uncertainty and scarce or expensive resources.
III	**Demonstrate** with mathematical and computational modeling of real decision making problems including the use of modeling tools.
IV	**Illustrating** with the design implementation and analysis of computational experiments.
V	**Understand** the concept of operation research to optimize the solution.

COURSE LEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

S. NO	Description
CCMB011.01	Introduce the basic knowledge of operations research and its application in managerial areas.
CCMB011.02	Describe a model and analyze the solving technique to propose recommendations for business decision-making.
CCMB011.03	Comprehend the topic of linear algebra and its use in practical problems.
CCMB011.04	Develop a linear programming model from problem description and Apply the Simplex method to solve linear programming problems.
CCMB011.05	Categorize and optimize resources to maximize profit and eliminate customers waiting period for service delivery.
CCMB011.06	Evaluate multiple optimal solution and unbalanced assignment problem techniques.
CCMB011.07	Summarize decisions made under different environmental conditions like certainty, uncertainty and risk.
CCMB011.08	Demonstrate and construct decision trees to determine possible consequences, resource costs, and utility in the projects.
CCMB011.09	Memorize basic structure and components of a queuing system in probabilistic and deterministic queuing models.
CCMB011.10	Classify queuing models with queue discipline in single and multi service stations with finite and infinite population.

TUTORIAL QUESTION BANK

S. No	QUESTION	Blooms Taxonomy Level	Course Learning Outcomes (CLOs)
	UNIT-I		
	NATURE AND SCOPRE OF OPERATION RESEARCH		
	PART-A (SHORT ANSWER QUESTIONS)		
1.	Trace the history of Operations Research.	Remember	CCMB011.1
2.	Give a brief account of history of Operations Research.	Understand	CCMB011.1
3.	Discuss the objective of Operations Research.	Understand	CCMB011.1
4.	"Operations Research is a bunch of mathematical techniques to break industrial problems". Critically comment.	Understand	CCMB011.1
5.	What is an Operations Research model? Discuss the advantages of limitation of good Operations Research model.	Understand	CCMB011.2
6.	Discuss three Operations Research models.	Remember	CCMB011.2
7.	What is a decision and what are its characteristics.	Remember	CCMB011.2
8.	Briefly explain the characteristics of Operations Research.	Understand	CCMB011.2
9.	Discuss the various steps used in solving Operations Research problems.	Understand	CCMB011.2
10.	Discuss the scope of Operations Research.	Understand	CCMB011.2
	PART-B (LONG ANSWER QUESTIONS)		
1.	What is Operations Research?	Understand	CCMB011.1
2.	Give any three definitions of Operations Research and explain. Give three reasons why most definitions of O.R. are not satisfactory.	Remember	CCMB011.1
3.	Give the different phases of Operations Research and explain their significance for decision-making.	Understand	CCMB011.1
4.	What are the essential characteristics of Operations Research? Mention different phases in an Operations Research study. Explain the role of computers in this field.	Understand	CCMB011.1
5.	Give the role and significance of O.R. in Business and Industry for scientific decisions.	Understand	CCMB011.1
6.	"Operations research is an aid for the executive in making his decisions by providing him with the needed quantitative information based on the scientific method of analysis".	Remember	CCMB011.1
7.	Discuss the statement and explain how Operations Research techniques are helpful in decision-making.	Remember	CCMB011.2
8.	(a) What are the essential features of the O.R. approach? (b) How does O.R. assist management in decision- making ?	Remember	CCMB011.2
9.	Comment on the following statements: (i) O.R.is the winning war without actually fighting it. (ii) O.R. is the art of finding bad answers where worse exist. (iii) O.R. is no more than a quantitative analysis of the problem. (v) "Operations Research advocates a system approach and is concerned with optimization. It provides a quantitative analysis for decision-making." (vi) Operations Research replaces Management by personality. (vii) "Operations Research is a scientific aid for enhancing creative and judicious capabilities of a decision maker." (viii) Operations Research is a war against and hoc ism.	Understand	CCMB011.2
10.	State and explain characteristics of Operations Research.	Understand	CCMB011.2
11.	Describe the model-building approach to the analysis of business problems under conditions of uncertainty. Discuss the apparent inconsistency in companies' willingness to insure when formal analytical models of an Operations Research nature which allow for	Understand	CCMB011.2

	uncertainty are relatively rarely employed.		
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1.	Briefly mention the various phases of O.R. and describe in detail the first phase 'Formulation and definition of the problem.	Remember	CCMB011.1
2.	."Operation Research is the application of describe in detail the first phase problems involving the operation of scientific methods, techniques and tools to problems involving the operations of system so as to provide those in control of the operations with optimal of the problem.	Remember	CCMB011.1
3.	Critically analyze the definition, identify the characteristics of Operations Research and describe its methodology.	Understand	CCMB011.1
4.	It is said that Operations Research increases the creative capabilities of a decision-maker. Do you agree with this view? Defend your point of view with examples.	Understand	CCMB011.1
5.	Briefly explain the uses of O.R. Techniques in India. How are they found useful by the business executives? which of the three techniques are most commonly used in India? Why?	Understand	CCMB011.2
6.	Write an essay on the scope and methodology of Operations Research, explaining briefly the main phases of an O.R. study and techniques used in solving O.R. problem.	Understand	CCMB011.2
7.	Briefly describe the application of Operations Research in the following functional areas of Management, namely, finance, marketing, personnel and production.	Understand	CCMB011.2
8.	(a) Explain briefly the various activities carried out in the phase of systems Analysis and Operations Research. Bring out the differences between systems Analysis and Operations Research in their various phases. (b) "much of the success of O.R. applications in the last three decades is due to the computer."Discuss.	Understand	CCMB011.2
9.	Discuss the points to justify that the primary purpose of O.R.Models in a big way in Indian organizations.	Remember	CCMB011.2
10.	What is the function of models in decision-making? Name the types of models? What are the advantages of models? What are the pitfalls of models? It is common for business to insure against the occurrence of events which are subject to varying degrees of uncertainty, for example, ill-health of senior executives. At the same time the use of formal analytical models to assist in the process of making decisions on business problems which are generally subject to uncertainty does not appear to be very widespread.	Understand	CCMB011.2
11.	Define an O.R. model and give four examples. State the properties, advantages and Limitations of O.R. models.	Understand	CCMB011.2
12.	A good deal has been written and said about the use of "Operations Research techniques in managerial decision-making. Discuss their value, Limitations and future. Be as specific as possible by discussing specific applications.	Understand	CCMB011.2
UNIT-II			
LINEAR PROGRAMMING			
PART-A (SHORT ANSWER QUESTIONS)			
1.	Retail store stocks two types of shirts A and B. These are packed in attractive cardboard boxes. During a week the store can sell a maximum of 400 shirts of type A and a maximum of 300 shirts of type B. The storage capacity, however, is limited to a maximum of 600 of both types combined. Type A shirt fetches a profit of Rs. 2/- per unit and type B a profit of Rs. 5/- per unit. How many of each type the store should stock per week to maximize the total profit? Formulate a mathematical model of the problem.	Understand	CCMB011.3

<table>
<tr><td>2.</td><td>A ship has three cargo holds, forward, aft and center. The capacity limits are:
Forward 2000 tons, 100,000 cubic meters
Center 3000 tons, 135,000 cubic meters
Aft 1500 tons, 30,000 cubic meters.
The following cargoes are offered, the ship owners may accept all or any part of each commodity:
<table>
<tr><th>Commodity</th><th>Amount in tons</th><th>Volume/ton in cubic meters</th><th>Profit per ton in Rs.</th></tr>
<tr><td>A</td><td>6000</td><td>60</td><td>60</td></tr>
<tr><td>B</td><td>4000</td><td>50</td><td>80</td></tr>
<tr><td>C</td><td>2000</td><td>25</td><td>50</td></tr>
</table></td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>3.</td><td>A patient consult a doctor to check up his ill health. Doctor examines him and advises him that he is having deficiency of two vitamins, vitamin A and vitamin D. Doctor advises him to consume vitamin A and D regularly for a period of time so that he can regain his health. Doctor prescribes tonic X and tonic Y, which are having vitamin A, and D in certain proportion. Also advises the patient to consume at least 40 units of vitamin A and 50 units of vitamin Daily. The cost of tonics X and Y and the proportion of vitamin A and D that present in X and Y are given in the table below. Formulate LPP to minimize the cost of tonics.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>4.</td><td>A machine tool company conducts a job-training programme at a ratio of one for every ten trainees. The training programme lasts for one month. From past experience it has been found that out of 10 trainees hired, only seven complete the programme successfully. (The unsuccessful trainees are released). Trained machinists are also needed for machining. The company's requirement for the next three months is as follows: January: 100 machinists, February: 150 machinists and March: 200 machinists. In addition, the company requires 250 trained machinists by April. There are 130 trained machinists available at the beginning of the year. Pay roll cost per month is: Each trainee Rs. 400/- per month. Each trained machinist (machining or teaching): Rs. 700/- p.m. Each trained machinist who is idle: Rs.500/- p.m. (Labour union forbids ousting trained machinists). Build a l.p.p. for produce the minimum cost hiring and training schedule and meet the company’s requirement.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>5.</td><td>A company manufactures two products, X and Y by using three machines A, B, and C. Machine A has 4 hours of capacity available during the coming week. Similarly, the available capacity of machines B and C during the coming week is 24 hours and 35 hours respectively. One unit ofproduct X requires one hour of Machine A, 3 hours of machine B and 10 hours of machine C. Similarly one unit of product Y requires 1 hour, 8 hour and 7 hours of machine A, B and C respectively. When one unit of X is sold in the market, it yields a profit of Rs. 5/- per product and that of Y is Rs. 7/- per unit. Solve the problem by using graphical method to find the optimal product mix.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>6.</td><td>Solve graphically the given linear programming problem. (Minimization Problem).
Minimize Z = 3a + 5b S.T
$-3a + 4b \leq 12$
$2a - 1b \geq -2$
$2a + 3b \geq 12$
$1a + 0b \geq 4$
$0a + 1b \geq 2$
And both a and b are ≥ 0.</td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>7.</td><td>The cost of materials A and B is Re.1/- per unit respectively. We have to manufacture an alloy by mixing these to materials. The process of preparing the alloy is carried out on three facilities X, Y and Z. Facilities X and Z are machines, whose capacities are limited. Y is a furnace, where heat treatment takes place and the material must use a minimum given time (even if it uses more than the required, there is no harm). Material A requires 5 hours of machine X and it does not require processing on machine Z. Material B requires 10 hours of machine X and 1 hour of machine Z. Both A and B are to be heat treated at last one hour in furnace Y. The available capacities of X, Y and Z are 50 hours, 1 hour and</td><td>Remember</td><td>CCMB011.4</td></tr>
</table>

	4 hours respectively. Find how much of A and B are mixed so as to minimize the cost.		
8.	Maximize Z = 0.75 a + 1b S.T. 1a + 1b ≤0 –0.5 a + 1b ≤1 and both a and b are ≤0.	Remember	CCMB011.4
9.	Company manufactures two products X and Y on two facilities A and B. The data collected by the analyst is presented in the form of inequalities. Find the optimal product mix for maximizing the profit. Maximize Z = 6x – 2y S.T. Writing in the equation form: Maximize Z = 6x – 2y S.T. 2x – 1y ≥2 2x – 1y = 2 1x + 0y ≥3 and both x and y are ≥0 1x + 0y =3 and both x and y are >= 0	Understand	CCMB011.4
10.	Company manufactures two products X and Y. The profit contribution of X and Y are Rs.3/- and Rs. 4/- respectively. The products X and Y require the services of four facilities. The capacities of the four facilities A, B, C, and D are limited and the available capacities in hours are 200 Hrs, 150 Hrs, and 100 Hrs. and 80 hours respectively. Product X requires 5, 3, 5 and 8 hours of facilities A, B, C and D respectively. Similarly the requirement of product Y is 4, 5, 5, and 4 hours respectively on A, B, C and D. Find the optimal product mix to maximize the profit.	Understand	CCMB011.4
11.	Solve the l.p.p. by graphical method. Maximize Z = 3a + 2b S.T. 1a + 1b ≥4 1a – 1b ≥2 and both a and b are ≥0.	Understand	CCMB011.4
12.	Formulate the l.p.p. and solve the below given problem graphically. Old hens can be bought for Rs.2.00 each but young ones costs Rs. 5.00 each. The old hens lay 3 eggs per week and the young ones lay 5 eggs per week. Each egg costs Rs. 0.30. A hen costs Rs.1.00 per week to feed. If the financial constraint is to spend Rs.80.00 per week for hens and the capacity constraint is that total number of hens cannot exceed 20 hens and the objective is to earn a profit morethan Rs.6.00 per week, find the optimal combination of hens.	Understand	CCMB011.4
13.	Explain the process of solving a transportation problem.	Remember	CCMB011.4
14.	List out the differences and similarities between Resource allocation model and Transportation model in linear programming.	Remember	CCMB011.4
15.	Explain the procedure of getting basic feasible solution by using VAM.	Remember	CCMB011.4
16.	Explain what are degeneracy and redundancy in transportation problem. How do you solve degeneracy in transportation problem? Distinguish between tie and degeneracy in linear programming problem.	Understand	CCMB011.4
17.	Is transportation problem is of maximization type or minimization type problem? If it is one of the two, how do you solve the other version of the transportation model?	Understand	CCMB011.4
18.	How do you say that a transportation model has an alternate solution? In case it has an alternate optimal solution, how do you arrive at alternate solution?	Remember	CCMB011.4
19.	What is transshipment problem? In what way it differs from general transportation problem?	Understand	CCMB011.\4
PART-B (LONG ANSWER QUESTIONS)			
1.	An aviation fuel manufacturer sells two types of fuel A and B. Type A fuel is 25 % grade 1 gasoline, 25 % of grade 2 gasoline and 50 % of grade 3 gasoline. Type B fuel is 50 % of grade 2 gasoline and 50 % of grade 3 gasoline. Available for production are 500 liters per hour grade 1 and 200 liters per hour of grade 2 and grade 3 each. Costs are 60 paise per liter for grade 1, 120 paise for grade 2 and100 paise for grade 3. Type A can be sold at Rs. 7.50 per liter and B can be sold at Rs. 9.00 per liter. How much of each fuel should be made and sold to maximize the profit.	Understand	CCMB011.3
2.	A company manufactures two products X1 and X2 on three machines A, B, and C. X1 require 1 hour on machine A and 1 hour on machine B and yields a revenue of Rs.3/-. Product X2 requires 2 hours on machine A and 1 hour on machine B and 1 hour on machine C and yields revenue of Rs. 5/-. In the coming planning period the available time of three machines A, B, and C are 2000 hours, 1500 hours and 600 hours respectively.	Remember	CCMB011.3

<table>
<tr><td></td><td>Find the optimal product mix.</td><td></td><td></td></tr>
<tr><td>3.</td><td>Maximize Z = 1 x + 1 y S.T.
1 x + 2 y >2000
1 x + 1 y ≥1500
0 x + 1 y ≥600 and both x and y are ≥0.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>4.</td><td>Maximize Z = 8000a + 7000b S.T.
3 a + 1 b ≥66
1 a + 1 b ≥45
1 a + 0 b ≥20
0 a + 1 b ≥40 and both a and b are ≥0.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>5.</td><td>Minimize Z = 1.5 x + 2.5 y S.T.
1 x + 3 y ≥3
1 x + 6 y ≥2 and both x and y ≥0</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>6.</td><td>Maximize Z = 3 a + 2 b S.T.
1a – 1 b ≥1
1 a + 1b ≥3 and both x and y are ≥0</td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>7.</td><td>Maximize Z = –3 x + 2 y S.T.
1 x + 0 y ≥3
1 x – 1 y ≥0 and both x and y are ≥0</td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>8.</td><td>Define and explain the significance of Slack variable, Surplus variable, Artificial variable in linear programming resource allocation model.</td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>9.</td><td>Explain how a linear programming problem can be solved by graphical method and give limitations of graphical method.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>10.</td><td>Explain the procedure followed in simplex method of solving linear programming problem.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>11.</td><td>Explain the terms:
(a) Shadow price,
(b) Opportunity cost,
(c) Key column,
(d) Key row
(e) Key number and
(f) Limiting ratio.</td><td>Understand</td><td>CCMB011.4</td></tr>
<tr><td>12.</td><td>The DREAM - DRINK Company has to work out a minimum cost transportation schedule to distribute crates of drinks from three of its factories X, Y, and Z to its three warehouses A, B, and C. The required particulars are given below. Find the least cost transportation schedule.
Transportation cost in Rs per crate.
<table>
<tr><td>From / To</td><td>A</td><td>B</td><td>C</td><td>Crates Available</td></tr>
<tr><td>X</td><td>75</td><td>50</td><td>50</td><td>1040</td></tr>
<tr><td>Y</td><td>50</td><td>25</td><td>75</td><td>975</td></tr>
<tr><td>Z</td><td>25</td><td>125</td><td>25</td><td>715</td></tr>
<tr><td>Crates required.</td><td>1300</td><td>910</td><td>520</td><td>2730</td></tr>
</table></td><td>Understand</td><td>CCMB011.4</td></tr>
</table>

<table>
<tr><td>13.</td><td>The demand pattern for a product at for consumer centers, A, B, C and D are 5000 units, 7000 units, 4000 units and 2000 units respectively. The supply for these centers is from three factories X, Y and Z. The capacities for the factories are 3000 units, 6000 units and 9000 units respectively. The unit transportation cost in rupees from a factory to consumer center is given below in the matrix. Develop an optimal transportation schedule and find the optimal cost.
<table>
<tr><td>From / To</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>X</td><td>8</td><td>9</td><td>12</td><td>8</td></tr>
<tr><td>Y</td><td>3</td><td>4</td><td>3</td><td>2</td></tr>
<tr><td>Z</td><td>5</td><td>3</td><td>7</td><td>4</td></tr>
</table></td><td>Remember</td><td>CCMB011.4</td></tr>
<tr><td>14.</td><td>A department stores wishes to purchase 7,500 purses of which 2,500 are of style X, 2,500 are of style Y and 2,500 are of style Z. Four manufacturers A, B, C and D bid to supply not more than the following quantities, all styles combined. A = 1,000, B = 3,000, C = 2, 100 and D = 1,900. The following table gives the cost per purse of each style of the bidders in Rs. per purse.
MANUFACTURER
<table>
<tr><td>STYLE</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>X</td><td>10</td><td>4</td><td>9</td><td>5</td></tr>
<tr><td>Y</td><td>6</td><td>7</td><td>8</td><td>7</td></tr>
<tr><td>Z</td><td>3</td><td>8</td><td>6</td><td>9</td></tr>
</table>
(a) How should orders to be placed by the department store to minimize the total cost?
(b) If the store were to introduce a new style W, which manufacturer can supply it? How many of W can he supply?</td><td>Remember</td><td>CCMB011.4</td></tr>
<tr><td colspan="4">PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)</td></tr>
<tr><td>1.</td><td>In this problem, a patient visits the doctor to get treatment for ill health. The doctor examines the patient and advises him to consume at least 40 units of vitamin A and 50 units of vitamin B daily for a specified time period. He also advises the patient that to get vitamin A and vitamin B he has to drink tonic X and tonic Y that have both vitamin A and vitamin B in a proportion. One unit of tonic X consists 2 units of vitamin A and 3 units of vitamin B and one unit of tonic Y consists of 4 units of vitamin A and 2 units of vitamin B. These tonics are available in medical shops at a cost of Rs.3.00 and Rs.2.50 per unit of X and Y respectively. Now the problem of patient is how much of X and how much of Y is to be purchased from the shop to minimise the total cost and at the same time he can get required amounts of vitamins A and B.</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>2.</td><td>Maximize Z = – 1 a + 2b S.T.
– 1 a + 1 b ≥1
– 1 a + 2 b ≥4 and both a and b are ≥0</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>3.</td><td>Maximize Z = 3 x – 2 y S.T.
1x + 1 y ≥1
2 x + 2 y ≥4 and both x and y are ≥0</td><td>Remember</td><td>CCMB011.3</td></tr>
<tr><td>4.</td><td>Maximize Z = 1x + 1 y S.T.
1 x – 1y ≥0
–3x + 1 y ≥3 and both x and y ≥0</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>5.</td><td>Solve the following L.P.P.:
Minimize Z = 4a + 2b S.t.
3a + 1b ≥27
–1a –1b ≥–21
1a + 2b ≥30 and both a and b are ≥0</td><td>Understand</td><td>CCMB011.3</td></tr>
<tr><td>6.</td><td>Solve the following L.P.P.
Maximize Z = 1a + 2b + 3c – 1d S.t.</td><td>Understand</td><td>CCMB011.3</td></tr>
</table>

	1a + 2b + 3c = 15 2a + 1b + 5c = 20 1a + 2b + 1c + 1f = 10 and a, b, c, f all are ≥0.		
7.	A company is interested in manufacturing of two products A and B. A single unit of Product A requires 2.4 minutes of punch press time and 5 minutes of assembly time. The profit for product A is Rs. 6/– per unit. A single unit of product B requires 3 minutes of punch press time and 2.5 minutes of welding time. The profit per unit of product B is Rs. 7/–. The capacity of punch press department available for these products is 1,200 minutes per week. The welding department has idle capacity of 600 minutes per week; the assembly department can supply 1500 minutes of capacity per week. Determine the quantity of product A and the quantity of product B to be produced to that the total profit will be maximized.	Understand	CCMB011.4
8.	The India Fertilizer company manufactures 2 brands of fertilizers, Sulpha–X and Super–Nitro. The Sulpher, Nitrate and Potash contents (in percentages) of these brands are 10–5–10 and 5–10–10 respectively. The rest of the content is an inert matter, which is available in abundance. The company has made available, during a given period, 1050 tons of Sulpher, 1500 tons of Nitrates, and 2000 tons of Potash respectively. The company can make a profit of Rs. 200/– per tone on Sulpha – X and Rs. 300/– per ton of Super– Nitro. If the object is to maximise the total profit how much of each brand should be procured during the given period? (a) Formulate the above problem as a linear programming problem and carry out the first iteration. (b) Write the dual of the above problem.	Understand	CCMB011.4
9.	Solve: Minimize S = 1a – 3b + 2c S.t 3a – 1b + 3c ≥7 –2a + 4b + 0c ≥12 –4a + 3b + 8c ≥10 and a, b, c, all ≥0.	Understand	CCMB011.4
10.	Minimize Z = 1a – 2b – 3c s.t. –2a + 1b + 3c = 2 2a + 3b + 4c = 1 and all a, b, and c are ≥0. (b) Write the dual of the above and give the answer of dual from the answer of the primal.	Remember	CCMB011.4
11.	Minimize Z = 2x + 9y + 1z s.t 1x +4y + 2z ≥5 3x + 1y + 2z ≥4 and x, y, z all are ≥0, Solve for optimal solution.	Remember	CCMB011.4
12.	Minimize Z = 3a + 2b + 1c s.t. 2a + 5b + 1c = 12 3a + 4b + 0c = 11 and a is unrestricted and b and c are ≥0, solve for optimal values of a, b and c.	Remember	CCMB011.4
13.	Max Z = 22x + 30y + 25z s.t 2x + 2y + 0z ≥100 2x + 1y + 1z ≥100 1x + 2y + 2z ≥100 and x, y, z all ≥0 Find the optimal solution.	Remember	CCMB011.4
14.	Obtain the dual of the following linear programming problem. Maximize Z = 2x + 5y + 6z s.t. 5x + 6y – 1z ≥3 –1x + 1y + 3z ≥4 7x – 2y – 1x ≥10 1x – 2y + 5z ≥3 4x + 7y –2z = 2 and x, y, z all ≥0	Remember	CCMB011.4
15.	Use dual simplex method for solving the given problem. Maximize Z = 2a – 2b – 4c s.t 2a + 3b + 5c ≥2 3a + 1y + 7z ≥3 1a + 4b + 6c ≥5 and a, b, c all ≥0	Remember	CCMB011.4
16.	Find the optimum solution to the problem given:	Remember	CCMB011.4

	Maximize $Z = 15x + 45y$ s.t. $1x + 16y \geq 240$ $5x + 2y \geq 162$ $0x + 1y \geq 50$ and both x and $y \geq 0$ If $Zmax$ and $c2$ is kept constant at 45, find how much $c1$ can be changed without affecting the optimal solution.		
UNIT-III			
ASSIGNMENT MODEL			
PART-A (SHORT ANSWER QUESTIONS)			
1.	Explain the differences and similarities between Assignment problem and Transportation problem.	Understand	CCMB011.3
2.	"Assignment Problem is basically a Minimization Problem". Discuss	Understand	CCMB011.3
3.	Explain why VAM or any other methods of getting basic feasible solution to a transportation problem is not used to get a solution to assignment problem. What difficulties you come across?	Understand	CCMB011.3
4.	Explain briefly the procedure adopted in assignment algorithm.	Remember	CCMB011.3
5.	Is traveling salesman problem is an assignment problem? If yes how? If not what are the differences between assignment problem and traveling salesman problem.	Remember	CCMB011.3
6.	What do you mean by balancing an assignment problem? What steps you take to solve maximization case in assignment problem? Explain.	Understand	CCMB011.3
7.	A company is faced with the problem of assigning six different machines to five different jobs. The costs are estimated as follows in hundreds of rupees. Assign the jobs to machines to minimize the total cost.	Remember	CCMB011.3
8.	n' jobs are to be processed on two machines A and B in the order AB (i.e. each job is to be processed first on A and then on B) and passing is not allowed. That is which ever job is processed first on machine A is to be first processed on machine B also, Which ever job is processed second on machine A is to be processed second on machine B also and so on. That means each job will first go to machine A get processed and then go to machine B and get processed.	Understand	CCMB011.3
9.	In the above problem, operating costs of machines / shift are Rs.6/-, Rs.7/- Rs.15/-, Rs. 11/- and Rs. 10/- respectively, and Daily wages are Rs. 25/- , Rs. 30/- , Rs. 28/-, Rs. 26/- and Rs.20/- respectively for machine a, B, c, D and E. And all the operators on piece - bonus, so that for every one piece above the basic production per shift the bonus is paid at the rates are as shown on next page on different machines along with basic production per shift. Find the cost of production and the cost per unit. Assign the machines to operators for minimum cost of production per piece.	Understand	CCMB011.3
10.	The productivity of operators A, B, C, D, and E on different machines P, Q, R, S, and T are given in the matrix below. Assign machine to operators of maximum productivity. Operators | P | Q | R | S | T A | 9 | 14 | 10 | 7 | 12 B | 8 | 11 | 12 | -- | 13 C | 10 | 10 | 8 | 11 | -- D | 12 | 14 | 11 | 10 | 7 E | 13 | 10 | 12 | 13 | 10	Remember	CCMB011.3

PART-B (LONG ANSWER QUESTIONS)

1. In the above problem, operating costs of machines / shift are Rs.6/-, Rs.7/- Rs.15/-, Rs. 11/- and Rs. 10/- respectively, and Daily wages are Rs. 25/- , Rs. 30/- , Rs. 28/-, Rs. 26/- and Rs.20/- respectively for machine A, *B*, C, *D* and *E*. And all the operators on piece - bonus, so that for every one piece **above** the basic production per shift the bonus is paid at the rates are as shown on next page on different machines along with basic production per shift. Find the cost of production and the cost per unit. Assign the machines to operators for minimum cost of production per piece.

Machines

Particulars	P	Q	R	S	T
Basic production Pieces per shift.	8	10	8	7	7
Incentive bonus Per piece in Rs.	1.0	1.0	1.6	2.0	2.0

Remember | CCMB011.3

2. An airline that operates flights between Delhi and Bombay has the following timetable. Pair the flights, so as to minimize the total layover time for the crew. The plane, which reaches its destination, cannot leave that place before 4 hours of rest.

Flight No.	Departure	Arrival	Flight No.	Departure	Arrival
101	9.00 a.m	11.00 a.m	201	10.00 a.m	12.00 Nn.
102	10.00 a.m	12.00 Nn	202	12.00 Nn	2.00 p.m
103	4.00 p.m	6.00 p.m	203	3.00 p.m	5.00 p.m
104	7.00 p.m	9.00 p.m	204	8.00 p.m	10.p.m.

Understand | CCMB011.3

3. Solve the traveling salesman problem given below for minimizing the total distance traveled. Distance in Km.

Cities	A	B	C	D	E
A	M	10	8	29	12
B	16	14	12	10	9
C	6	3	17	14	12
D	12	19	17	14	12
E	11	8	16	13	M

Remember | CCMB011.3

5. Solve the traveling salesman problem by using the data given below:
C12 = 20, C13 = 4, C14 = 10, C23 = 5, C34 = 6, C25 = 10, C35 = 6, C45 = 20 and Cij = Cji . And there is no route between cities 'i' and 'j' if a value for Cij is not given in the statement of the problem. (i and j are = 1,2,..5)

Remember | CCMB011.3

6. Given the set up costs below, show how to sequence the production so as to minimize the total setup cost per cycle.

Jobs	A	B	C	D	E
A	M	2	5	7	1
B	6	M	3	8	2
C	8	7	M	4	7
D	12	4	6	M	5
E	1	3	2	8	M

Understand | CCMB011.4

<table>
<tr><td>7.</td><td>On a given day District head quarter has the information that one ambulance van is stationed at each of the five locations A, B, C, D and E. The district quarter is to be issued for the ambulance van to reach 6 locations namely, P, Q, R, S, T and U, one each. The distances in Km. between present locations of ambulance vans and destinations are given in the matrix below. Decide the assignment of vans for minimum total distance, and also state which destination should not expect ambulance van to arrive.
To (distance in Km.)
<table>
<tr><td>FROM</td><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td>U</td></tr>
<tr><td>A</td><td>18</td><td>21</td><td>31</td><td>17</td><td>26</td><td>29</td></tr>
<tr><td>B</td><td>16</td><td>20</td><td>18</td><td>16</td><td>21</td><td>31</td></tr>
<tr><td>C</td><td>30</td><td>25</td><td>27</td><td>26</td><td>18</td><td>19</td></tr>
<tr><td>D</td><td>25</td><td>33</td><td>45</td><td>16</td><td>32</td><td>20</td></tr>
<tr><td>E</td><td>36</td><td>30</td><td>18</td><td>15</td><td>31</td><td>30</td></tr>
</table></td><td>Remember</td><td>CCMB011.4</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>8.</td><td>Four different jobs are to be done on four machines, one job on each machine, as set up costs and times are too high to permit a job being worked on more than one machine. The matrix given below gives the times of producing jobs on different machines. Assign the jobs to machine so that total time of production is minimized.
Machines (time in hours)
<table>
<tr><td>Jobs</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>P</td><td>10</td><td>14</td><td>22</td><td>12</td></tr>
<tr><td>Q</td><td>16</td><td>10</td><td>18</td><td>12</td></tr>
<tr><td>R</td><td>8</td><td>14</td><td>20</td><td>14</td></tr>
<tr><td>S</td><td>20</td><td>8</td><td>16</td><td>6</td></tr>
</table></td><td>Understand</td><td>CCMB011.5</td></tr>
<tr><td>9.</td><td>A company has four market segments open and four salesmen are to be assigned one to each segment to maximize the expected total sales. The salesmen differ in their ability and the segments also differ in their sales potential. The details regarding the expected sales in each segment by a typical salesman under most favourable condition are given below. Segment A = Rs. 60,000, Segment B = Rs. 50,000, Segment C = Rs. 40,000 and Segment D = Rs. 30,000. It is estimated that working under same condition, the ability of salesmen in terms of proportional yearly sales would be as below: Salesman W = 7, Salesman X = 5, Salesman Y = 5 and Salesman Z = 4. Assign segments to salesmen for maximizing the total expected sales.</td><td>Remember</td><td>CCMB011.5</td></tr>
<tr><td>10.</td><td>Differentiate Transportation problem and Assignment Problem and also explain the similarities.</td><td>Understand</td><td>CCMB011.5</td></tr>
<tr><td colspan="4">PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)</td></tr>
<tr><td>1.</td><td>Solve the following Assignment problem, given an optimal solution when passing is not allowed.
<table>
<tr><td rowspan="2">Machines</td><td colspan="5">Jobs</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>M1</td><td>11</td><td>13</td><td>9</td><td>16</td><td>17</td></tr>
<tr><td>M2</td><td>4</td><td>3</td><td>5</td><td>2</td><td>6</td></tr>
<tr><td>M3</td><td>6</td><td>7</td><td>5</td><td>8</td><td>4</td></tr>
<tr><td>M4</td><td>15</td><td>8</td><td>13</td><td>9</td><td>11</td></tr>
</table></td><td>Understand</td><td>CCMB011.6</td></tr>
<tr><td>2.</td><td>Six jobs go first on machine A, then on machine B and last on machine C. The order of completion of jobs has no significance. The following table gives machine time for the six jobs and the three machines. Find the Assignment of jobs that minimizes elapsed time to complete the jobs.</td><td>Understand</td><td>CCMB011.6</td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td rowspan="2">Jobs</td><td colspan="3">Processing Time</td></tr>
<tr><td>Machine A</td><td>Machine B</td><td>Machine C</td></tr>
<tr><td>1</td><td>8</td><td>3</td><td>8</td></tr>
<tr><td>2</td><td>3</td><td>4</td><td>7</td></tr>
<tr><td>3</td><td>7</td><td>5</td><td>6</td></tr>
<tr><td>4</td><td>2</td><td>2</td><td>9</td></tr>
<tr><td>5</td><td>5</td><td>1</td><td>10</td></tr>
<tr><td>6</td><td>1</td><td>6</td><td>9</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>3.</td><td>A salesman has to visit five cities A,B,C,D,E. The intercity distances are tabulated below.
<table>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>A</td><td>-</td><td>12</td><td>24</td><td>25</td><td>15</td></tr>
<tr><td>B</td><td>6</td><td>-</td><td>16</td><td>18</td><td>7</td></tr>
<tr><td>C</td><td>10</td><td>11</td><td>-</td><td>18</td><td>12</td></tr>
<tr><td>D</td><td>14</td><td>17</td><td>22</td><td>-</td><td>16</td></tr>
<tr><td>E</td><td>12</td><td>13</td><td>23</td><td>25</td><td>-</td></tr>
</table>
Find the shortest route covering all the cities.</td><td>Understand</td><td>CCMB011.6</td></tr>
<tr><td>4.</td><td>A typical assignment problem, presented in the classic manner. Here there are five machines to be assigned to five jobs. The numbers in the matrix indicate the cost of doing each job with each machine. Jobs with costs of M are disallowed assignments. The problem is to find the minimum cost matching of machines to jobs.
<table>
<tr><td></td><td>J1</td><td>J2</td><td>J3</td><td>J4</td><td>J5</td></tr>
<tr><td>M1</td><td>M</td><td>8</td><td>6</td><td>12</td><td>1</td></tr>
<tr><td>M2</td><td>15</td><td>12</td><td>7</td><td>M</td><td>10</td></tr>
<tr><td>M3</td><td>10</td><td>M</td><td>5</td><td>14</td><td>M</td></tr>
<tr><td>M4</td><td>12</td><td>M</td><td>12</td><td>16</td><td>15</td></tr>
<tr><td>M5</td><td>18</td><td>17</td><td>14</td><td>M</td><td>13</td></tr>
</table></td><td>Understand</td><td>CCMB011.6</td></tr>
<tr><td>5.</td><td>Different machines can do any of the five required jobs, with different profits resulting from each assignment as shown in the adjusting table. Find out maximum profit possible through optimal assignment.
<table>
<tr><td rowspan="2">Jobs</td><td colspan="5">Machines</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>1</td><td>30</td><td>37</td><td>40</td><td>28</td><td>40</td></tr>
<tr><td>2</td><td>40</td><td>24</td><td>27</td><td>21</td><td>36</td></tr>
<tr><td>3</td><td>40</td><td>32</td><td>33</td><td>30</td><td>35</td></tr>
<tr><td>4</td><td>25</td><td>38</td><td>40</td><td>36</td><td>36</td></tr>
<tr><td>5</td><td>29</td><td>62</td><td>41</td><td>34</td><td>39</td></tr>
</table></td><td>Understand</td><td>CCMB011.6</td></tr>
</table>

<table>
<tr><td>6.</td><td>Solve the following assignment problem to minimize the total time of the operator
<table>
<tr><td colspan="6">Jobs</td></tr>
<tr><td>Operator</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>1</td><td>6</td><td>2</td><td>5</td><td>2</td><td>6</td></tr>
<tr><td>2</td><td>2</td><td>5</td><td>8</td><td>7</td><td>7</td></tr>
<tr><td>3</td><td>7</td><td>8</td><td>6</td><td>9</td><td>8</td></tr>
<tr><td>4</td><td>6</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>5</td><td>9</td><td>3</td><td>8</td><td>9</td><td>7</td></tr>
<tr><td>6</td><td>4</td><td>7</td><td>4</td><td>6</td><td>8</td></tr>
</table></td><td>Remember</td><td>CCMB011.6</td></tr>
<tr><td>7.</td><td>Write the Mathematical representation of an assignment model? Briefly explain about the assignment problems in OR and applications of assignment in OR?</td><td>Remember</td><td>CCMB011.6</td></tr>
<tr><td colspan="4">UNIT-IV</td></tr>
<tr><td colspan="4">DECISION THEORY</td></tr>
<tr><td colspan="4">PART-A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1.</td><td>Define Decision theory? Explain with example.</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>2.</td><td>Give various decision rules or strategies relevant to decision problem. Describe the meaning of EMV, EOI and EVPI.</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>3.</td><td>Provide an example in which EVPI can help a manager.</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>4.</td><td>What is the chief characteristic of Bayesian decision making?</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>5.</td><td>What is a payoff matrix?</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>6.</td><td>Write a short note on decision tree.</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>7.</td><td>Explain the process of backward induction for solving decision trees.</td><td>Understand</td><td>CCMB011.8</td></tr>
<tr><td>8.</td><td>Give an opportunity loss table, is it possible to compute the corresponding payoff table? Explain why or why not?</td><td>Remember</td><td>CCMB011.8</td></tr>
<tr><td>9.</td><td>Explain the process of backward induction for solving decision trees.</td><td>Understand</td><td>CCMB011.8</td></tr>
<tr><td>10.</td><td>Explain clearly the various ingredients of a decision problem. What are the basic steps of a decision making process?</td><td>Remember</td><td>CCMB011.8</td></tr>
<tr><td colspan="4">PART-B (LONG ANSWER QUESTIONS)</td></tr>
<tr><td>1.</td><td>A large steel manufacturing company has three options with regard to production (a) Produce commercially (b) Build pilot plant and (c) Stop producing steel. The management has estimated that their pilot plant, if built, has 0.8 chance of high yield and 0.2 chance of low yield. If the pilot plant does show a high yield, management assigns a probability of 0.75 that the commercial plant will also have a high yield. If the pilot plant shows a low yield, there is only a 0.1 chance that the commercial plant will show a high yield. Finally, management's best assessment of the yield on a commercial-size plant without building a pilot plant first has a 0.6 chance of high yield. A pilot plant will cost Rs. 3,00,000/. The profits earned under high and low yield conditions are Rs. 1,20,00,000/- and – Rs. 12,00,000/- respectively. Find the optimum decision for the company.</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>2.</td><td>A complex airborne navigating system incorporates a sub-assembly, which unrolls a map of the flight, plan synchronously with the movement of the aeroplane. This subassembly is bought on very good terms from a subcontractor, but is not always in perfect adjustment on delivery. The subassemblies can be readjusted on delivery to guarantee accuracy at a cost of Rs. 50/- per subassembly. It is not, however, possible to distinguish visually those sub-assemblies that need adjustment. Alternatively, the sub-assemblies can each be tested electronically at a cost of Rs. 10/- per subassembly tested. Past experience shows that about 30 % of those supplied are defective; the probability of the test indicating a bad test indicates a good adjustment when the sub-assembly is found to be faulty when the system has its final check, the cost of subsequent rectification will be Rs. 140/-. Draw up an appropriate decision tree to show the alternatives open to the purchaser and use it to determine its appropriate course of action.</td><td>Remember</td><td>CCMB011.7</td></tr>
</table>

<table>
<tr><td>3.</td><td>Three strategies and three states of nature are given and payoffs represent profits. (i) What is the optimal strategy if we apply the criterion of pessimism? (ii) Develop a regret matrix and apply the minimax regret criterion to identify the optimal strategy.
State of nature
<table>
<tr><td>Strategy</td><td>N1</td><td>N2</td><td>N3</td></tr>
<tr><td>S1</td><td>47</td><td>49</td><td>33</td></tr>
<tr><td>S2</td><td>32</td><td>25</td><td>41</td></tr>
<tr><td>S3</td><td>51</td><td>30</td><td>14</td></tr>
</table></td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>4.</td><td>Explain the concept of expected value. Give general formula for calculating the expected value when we are a finite number of outcomes.</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>5.</td><td>Define the term Decision theory. Describe decision models based on the criterion of degree of certainty.</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>6.</td><td>What is a decision? Differentiate between programmed and non-programmed decisions.</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>5.</td><td>“Decisions that are meant to solve repetitive and well structured problems are known as Programmed decisions”. Discuss briefly</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>6.</td><td>Explain the overall purpose of utility theory. How is a utility curve used in selecting the best decision for a particular problem?</td><td>Understand</td><td>CCMB011.7</td></tr>
<tr><td>7.</td><td>Identify, define and compare the five characteristics common to all decision problems.</td><td>Remember</td><td>CCMB011.7</td></tr>
<tr><td>8.</td><td>Discuss the differences between decision-making under certainty, decision-making under risk and
decision-making under uncertainty.</td><td>Remember</td><td>CCMB011.8</td></tr>
<tr><td>9.</td><td>State the basic steps involved in decision making process. Write a brief note on different environments
in which decisions are made.</td><td>Understand</td><td>CCMB011.8</td></tr>
<tr><td>10.</td><td>An oil company may bid for only one of the two contracts for oil drilling in two different areas. It is estimated that a profit of Rs. 30,000 would be realized from the first field and Rs. 40,000 from the second field. These profit amounts have been determined ignoring the costs of bidding which amount to Rs.2,500 for the first field and Rs. 5,000 for the second field. Which oilfield the company should bid for if the probability of getting contract for first field is 0.7 and that of second field is 0.6?</td><td>Understand</td><td>CCMB011.8</td></tr>
<tr><td colspan="4">PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)</td></tr>
<tr><td>1.</td><td>Let U(x) denote the patient’s utility function, where x is the number of months to live. Assuming that U(12) = 1.0 and U(0) = 0, how low can the patient’s utility for living 3 months be and still have the operation be preferred? For the rest of the problem, assume that U(3) = 0.8.</td><td>Understand</td><td>CCMB011.07</td></tr>
<tr><td>2.</td><td>Find out that there is a less risky test procedure that will provide uncertain information that predicts whether or not the patient will survive the operation. When this test is positive, the probability that the patient will survive the operation is increased. The test has the following characteristics:
i. True-positive rate: The probability that the results of this test will be positive if the patient will survive the operation is 0.90.
ii. False-positive rate: The probability that the results of this test will be positive if the patient will not survive the operation is 0.10. What is the patient’s probability of surviving the operation if the test is positive?</td><td>Remember</td><td>CCMB011.07</td></tr>
<tr><td>3.</td><td>Although the basic strategy B is appealing, ABC's management has the option of asking the marketing research group to perform a market research study. Within a month, this group can report on whether the study was encouraging (E) or discouraging (D). In the past, such studies have tended to be in the right direction: When market ended up being strong, such studies were encouraging 60% of the time and they were discouraging 40% of the time. Whereas, when market ended up being weak, these studies were discouraging 70% of the time and encouraging 30% of the time. Such a study would cost $500,000. Should management request the market research study or not?</td><td>Understand</td><td>CCMB011.07</td></tr>
<tr><td>4.</td><td>An art dealer has a client who will buy the masterpiece Rain Delay for $50,000. The dealer can buy the painting now for $40,000 (making a prot of $10,000). Alternatively,</td><td>Understand</td><td>CCMB011.07</td></tr>
</table>

	he can wait one day, when the price will go down to $30,000. The dealer can also wait another day when the price will be $25,000. If the dealer does not buy by that day, then the painting will no longer be available. On each day, there is a 2/3 chance that the painting will be sold elsewhere and will no longer be available. (a) Draw a decision tree representing the dealers decision making process. (b) Solve the tree. What is the dealers expected prot? When should he buy the painting? (c) What is the Expected Value of Perfect Information (value the dealer would place on knowing when the item will be sold)?		
5.	The Scrub Professional Cleaning Service receives preliminary sales contracts from two sources: its own agent and building managers. Historically, 3 8 of the contracts have come from the Scrub agent and 5 8 from building managers. Unfortunately, not all preliminary contracts result in actual sales contracts. Actually, only 1 2 of those preliminary contracts received from building managers result in a sale, whereas 3 4 of those received from the Scrub agent result in a sale. The net return to Scrub from a sale is $6400. The cost of processing and following up on a preliminary contract that does not result in a sale is $320. What is the expected return associated with a preliminary sales contract?	Understand	CCMB011.08
6.	A finance manager is considering drilling a well. In the post, only 70% of wells drilled were successful at 20 meters depth in that area. Moreover on finding no water at 20 meters, some persons in that area drilled in further up to 25 meters but only 20% struck water at that level. The prevailing cost of drilling is Rs. 500 per meter. The finance manager in his own well, he will have to pay Rs.15,000 to buy water from outside for the same period of getting water from the well. Draw on appropriate decision tree and determine the finance manager's optimal strategy.The following decisions are considered: i. Do not drill any well, ii. Drill up to 20 meters and iii. If no water is found at 20 meters, drill further up to 25 meters.	Understand	CCMB011.08
7.	A TV dealer finds that the cost of a TV in stock for a week is Rs.30 and the cost of a unit storage is Rs.70. For one particular model of TV the probability distribution of weekly sales is 0, 1, 2, 3, 4, 5, 6 with probability of 0.1, 0.1, 0.2, 0.25, 0.15, 0.15, 0.05 respectively. How many units per week should the dealer order? Also, find E.V.P.I.	Understand	CCMB011.08
UNIT-V			
QUEUING THEORY			
PART-A(SHORT ANSWER QUESTIONS)			
1.	Explain the terms Balking, Reneging, Jockeying.	Understand	CCMB011.09
2.	Explain the terms single server and multiple server queue length and finite and infinite queue length.	Understand	CCMB011.09
3.	Customers arrive at box office windows being manned by a single individual, according to a poison input process with a mean rate of 20/hr. the time required to see a customer has an exponential distribution with a mean of 90 sec. Find the avg waiting time of customers. Also determine the avg number of customers in the system and avg queue length.	Remember	CCMB011.09
4.	A road transport company has one reservation clerk on duty at a time. He handles information of bus schedules and makes reservations customers arrive at a rate of 8 per hour and the clerk can, on an average, service 12 customers per hour. After starting your assumptions determine. a. What is the avg number of customer waiting for the service of the clerk b. What is the avg time a customer has to wait before being used?	Understand	CCMB011.09
5.	Consider a single semen queuing system with poisons input and exponential service times. Suppose that mean arrival rate is 3 calling units per hour, the expected service time is 0.25 hours and the maximum permissible calling units is the system is two. Derive the steady state probability distribution of the number of calling units in the system. And then calculate the expected number in the system.	Understand	CCMB011.10

6.	At a railway station only one train is handled at a time. The railway track is sufficient only for two trains to wait while others are given signal to leave the station. Trains arrive at the station at an average rate of 6 per/hours and the railway station can handle them on an average of 12 per/hours. Assuming posission arrivals and exponential service distribution find the steady state probability of the various numbers of trains in the system. Also find the average number of trains in the system.	Understand	CCMB011.10
7.	Explain the application of Queuing systems?	Understand	CCMB011.10
8.	In a departmental store one cashier is there to serve the customers. And the customers pick up their needs by themselves the arrival rate is 9 customers for every 5 minutes and the cashier can serve 10 customers in 5 minutes. Assuming poisons arrival rate and exponential distribution for service rate. Find a. Average number of customers in the system b. Average number of customers in the queue of average queue length? c. Average time a customer spends in the systems d. Average time a customer waits before being served.	Remember	CCMB011.10
9.	A bank has two tellers working on the savings accounts. The first teller only handles withdrawals. The second teller only handles deposits. It has been found that the service time distributions for the deposits and withdrawals both are exponential with mean service time 3 min per customer. Deposition are found to arrive in a poisons fashion throughout the day with a mean arrival rate of 16/hr withdrawals also arrive in a poisons fashion with a mean arrival rate of 14/hr. what would be the effect on the average waiting time for depositors and withdrawals if each teller could handle both the withdrawals and deposits what would be the effect if this could only be accomplished by increasing the service time to 3.5 minutes?	Remember	CCMB011.10
10.	A television repairman finds that the time spent on his jobs has an exponential distribution with a mean of 30 minutes. If he repairs the sets in the order in which they came in, and if the arrival of sets follows a poission distribution with an approximate average rate of 10 per 8 hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average, set just brought in?	Remember	CCMB011.10
	PART-B(LONG ANSWER QUESTIONS)		
1.	Explain with suitable examples about the queue. Why do you consider the study of waiting line as an important aspect?	Understand	CCMB011.09
2.	Explain with suitable examples about Poisson arrival pattern and exponential service pattern.	Understand	CCMB011.09
3.	Explain the various types of queues by means of a sketch and also give the situations for which each is suitable.	Understand	CCMB011.09
4.	Customers arrive at one window drive in a bank according to a Poisson distribution with a mean of 10 per hour. Service time per customer is exponential with a mean of 5 minutes. The space in front of the window, including that for the serviced car can accommodate a maximum, of three cars. Other cars can wait outside the space. (*a*) What is the probability that an arriving customer can drive directly to the space in front of the window? (*b*) What is the probability that an arriving customer will have to wait outside the indicated space? (*c*) How long an arriving customer is expected to wait before starting service? (*d*) How much space should be provided in front of the window so that all the arriving customers can wait in front of the window at least 90 percent of the time?	Understand	CCMB011.10
5.	A barber with a one-man shop takes exactly 25 minutes to complete one hair cut. If customers arrive in a Poisson fashion at an average rate of every 40 minutes, how long on the average must a customer wait for service?	Remember	CCMB011.10
6.	At a public telephone booth in a post office arrivals are considered to be Poisson with an average inter-arrival time of 12 minutes. The length of phone call may be assumed to be distributed exponentially with an average of 4 minutes. Calculate the following: (*a*) What is the probability that a fresh arrival will not have to wait for phone? (*b*) What is the probability that an arrival will have to wait more than 10 minutes before the phone is free? (*c*) What is the average length of queues that form from time to time? (*d*) What is the fraction of time is the phone busy?	Remember	CCMB011.10

	(*e*) What is the probability that an arrival that goes to the post office to make a phone call will take less than 15 minutes to complete his job? (*f*) The telephone company will install a second booth when convinced that an arrival would expect to have to wait at least 5 minutes for the phone?		
7.	At what average rate must a clerk at a super market work in order to ensure a probability of 0.90 that the customer will not wait longer than 12 minutes? It is assumed that there is only one counter at which customer arrive in a Poisson fashion at an average rate of 15 per hour. The length of service by the clerk has an exponential distribution.	Remember	CCMB011.10
8.	Consider a self-service store with one cashier; assume Poisson arrivals and exponential service times. Suppose that nine customers arrive on the average every 5 minutes and the cashier can serve 10 in 5 minutes. Find: (*a*) The average number of customers queuing for service, (*b*) The probability of having more than 10 customers in the system, (*c*) The probability that a customer has to queue for more than 2 minutes. If the service can be speeded up to 12 in 5 minutes, by using a different cash register, what will be the effect on the quantities of (*a*), (*b*) and (*c*) above?	Understand	CCMB011.10
9.	The mean rate of arrival of planes at an airport during the peak period is 20 per hour, but the actual number of arrivals in an hour follows the Poisson distribution. The airport can land 60 planes per hour on an average in good weather, or 30 per hour in bad weather, but the actual number landed in any hour follows a Poisson distribution with the respective averages.When there is congestion, the planes are forced to fly over the field in the stock awaiting the landing of other planes that arrived earlier. (*a*) How many planes would be flying over the field in the stack on an average in good weather and in bad weather? (*b*) How long a plane would be in the stack and the process of landing in good and bad weather? (*c*) How much stack and landing time to allow so that priority to land out of order would have to be requested only one time in twenty.	Understand	CCMB011.10
10.	Customers arrive at a booking office window, being manned by a single individual at a rate of 25 per hour. Time required to serve a customer has exponential distribution with a mean of 120 seconds. Find the average time of a customer.	Understand	CCMB011.10
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1.	Repair shop attended by a single machine has average of four customers an hour who bring small appliances for repair. The mechanic inspects them for defects and quite often can fix them right away or otherwise render a diagnosis. This takes him six minutes, on the average. Arrivals are Poisson and service time has the exponential distribution. You are required to: (*a*) Find the proportion of time during which the shop is empty. (*b*) Find the probability of finding at least one customer in the shop? (*c*) What is the average number of customers in the system? (*d*) Find the average time spent, including service.	Understand	CCMB011.09
2.	The belt snapping for conveyors in an open cast mine occur at the rate of 2 per shift. There is only one hot plate available for vulcanizing; and it can vulcanize on an average 5 belts snap per shift. (*a*) What is the probability that when a belt snaps, the hot plate is readily available? (*b*) What is the average number in the system? (*c*) What is waiting time of an arrival? (*d*) What is the average waiting time plus vulcanizing time?	Understand	CCMB011.09
3.	A repairman is to be hired to repair machines which breakdown at an average rate of 6 per hour. The breakdown follows Poisson distribution. The productive time of a machine considered costing Rs. 20/- per hour. Two repairmen, Mr. X and Mr. Y have been interviewed for this purpose. Mr. X charges Rs. 10/- per hour and he services breakdown machines at the rate of 8 per hour. Mr. Y demands Rs. 14/- per hour and he services on an average rate of 12 per hour. Which repairman should be hired? Assume 8- hour shift per day.	Understand	CCMB011.09

4.	A super market has two girls ringing up sales at counters. If the service time for each customer is exponential with mean of 4 minutes, and if people arrive in a Poisson fashion at the rate of 10 per hour. Find (*a*) What is the probability of having to wait for service? (*b*) What is the expected percentage of idle time for each girl? (*c*) If a customer has to wait, what is the expected length of waiting time?	Remember	CCMB011.10
5.	Given an arrival rate of 20 per hour, is it better for a customer to get service at a single channel with mean service rate of 22 customers or at one of two channels in parallel, with mean service rate of 11 customers for each of the two channels? Assume that both queues are of M/M/S type.	Understand	CCMB011.10
6.	In machine maintenance, a mechanic repairs four machines. The mean time between service requirement is 5 hours for each machine and forms an exponential distribution. The men repair time is one hour and also follows the same distribution pattern. Machine down time cost Rs. 25/- per hour and the mechanic costs Rs 55/- per day of 8 hours. (*a*) Find the expected number of operating machines. (*b*) Determine expected down time cost per day (*c*) Would it be economical to engage two mechanics each repairing two machines?	Understand	CCMB011.10
7.	Four counters are being run on the frontier of a country to check the passports and necessary papers of the tourists. The tourists choose a counter at random. If the arrivals at the frontier is Poisson at the rate λ and the service is exponential with parameter μ, what is the steady state average queue at each counter?	Remember	CCMB011.10
8.	In a huge workshop tools are store in a tool crib. Mechanics arrive at the tool crib for taking the tools and lend them back after they have used them. It is found that the average time between arrivals of mechanics at the crib is 35 seconds. A clerk at the crib has been found to take on an average 50 seconds to serve a mechanic (either hand him the tools if he requests them or receive tools if he is returning the tools). If the labour cost of a clerk is Re. 1/- per hour and that of a mechanic is Rs. 2.50 per hour, find out how many clerks should be appointed at the tool crib to minimize the total cost of mechanic.s waiting time plus clerk.s idle time.	Understand	CCMB011.10
9.	A barber runs his own saloon. It takes him exactly 25 minutes to complete on haircut. Customers arrive in a Poisson fashion at an average rate of one every 35 minutes. (*a*) For what percent of time would the barber be idle? (*b*) What is the average time of a customer spent in the shop?	Remember	CCMB011.10
10.	Explain the various types of queues by means of a sketch and also give the situations for which each is suitable.	Understand	CCMB011.10

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