Name: **Enrolment No:**	UPES

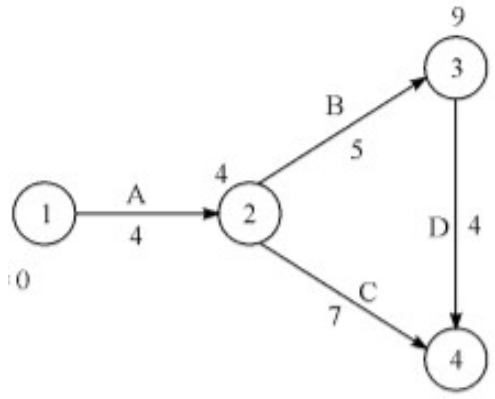
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Program Name: B-Tech ME (Core and specialization) **Semester: VI**
Course Name: Operations Research **Time: 03 hrs**
Course Code: IPEG452 **Max. Marks: 100**
Nos. of page(s): 5
Instructions: If data is insufficient, make relevant assumptions and state the same.
Graph sheet and statistical table shall be supplied to students on request.

SECTION A (60 marks)

Sl. No.			Marks	CO
Q1	i.	If there are 'n' jobs and 'm' machines, there will be ..... sequences of doing the jobs. (a) n × m, (b) m × n, (c) n^m, (d) $(n!)^m$	**10x1=10**	**CO1**
	ii.	The following is one of the assumptions made while sequencing 'n' jobs on 2 machines (a) Two jobs must be loaded at a time on any machine, (b) Jobs are to be done alternatively on each machine, (c) The order of completing the jobs has high significance, (d) Each job once started on a machine is to be performed up to completion on that machine		
	iii.	In the matrix of a game given below the negative entries are: B A: I (1, -1); II (-1, 1) (a) Payments from A to B (b) Payments from B to A (c) Payment from players to organisers (d) Payment to players from organisers.		
	iv.	When there is dominance in a game then (a) Least of the row ≥ highest of another row, (b) Least of the row ≤ highest of another row, (c) Every element of a row ≥ corresponding element of another row, (d) Every element of the row ≤ corresponding element of another row		
	v.	A steady state exists in a queue if:		

	(a) $\lambda > \mu$, (b) $\lambda < \mu$, (c) $\lambda = \mu$, (d) $\lambda = \mu$. vi. In queue designation A/B/S : (d/f), what does S represent? (a) Arrival Pattern, (b) Service Pattern (c) Number of service channels, (d) Capacity of the system. vii. As per queue discipline the following is not a negative behavior of a customer: (a) Balking, (b) Reneging, (c) Boarding, (d) Collusion viii. If two jobs J1 and J2 have same minimum process time under first machine but processing time of J1 is less than that of J2 under second machine, then J1 occupies (a) First available place from the left, (b) Second available place from the left, (c) First available place from the right, (d) Second available place from the right ix. The total number of allocation in a basic feasible solution of transportation problem of m × n size is equal to (a) m × n,(b) (m / n) – 1, (c) m + n +1 (d) m + n – 1. x. If Dual has a solution, then the primal will (a) Not have a solution, (b) Have only basic feasible solution, (c) Have a solution (d) None of the above		
Q 2	i. Define Total float and free float. What is the significance of calculating floats in project management? ii. Calculate the total float and free float of the non-critical activities in the following network  	**5x2 =10**	**CO1** **CO2**
Q 3	A manager has 4 jobs on hand to be assigned to 3 of his clerical staff. Clerical staff differs in efficiency. The efficiency is a measure of time taken by them to do various jobs. The manager wants to assign the duty to his staff, so that the total time taken by the staff should be minimum. The matrix given below shows the time taken by each person to do a particular job. Help the manager in assigning the jobs to the personnel.	**10**	**CO3**

	<table><tr><td>*Jobs.*</td><td colspan="3">*Men (time taken to do job in hours).*</td></tr><tr><td></td><td>X</td><td>Y</td><td>Z</td></tr><tr><td>A</td><td>10</td><td>27</td><td>16</td></tr><tr><td>B</td><td>14</td><td>28</td><td>7</td></tr><tr><td>C</td><td>36</td><td>21</td><td>16</td></tr><tr><td>D</td><td>19</td><td>31</td><td>21</td></tr></table>		
Q4	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?	**10**	**CO4**
Q5	Two children play the following game, named as 'Scissors, Paper, and Stone' (S, P, St.). Both players simultaneously call one of the three: Scissors, Paper or Stone. Scissors beat paper as paper can be cut by scissor, Paper beats stone as stone can be wrapped in paper, and stone beats scissors as stone can blunt the scissors. If both players name the same item, then there is a tie. If there is one point for win, zero for the tie and –1 for the loss. Form the pay of matrix and write the optimal strategies	**10**	**CO4**
Q6	At a service station a study was made over a period of 25 days to determine both the number of automobiles being brought in for service and the number of automobiles serviced. The results are given below. No. of automobiles arriving and serviced: 0 1 2 3 4 5 Frequency of arrivals (days): 2 4 10 5 3 1 Frequency of daily serviced (days): 3 2 12 3 4 1 Simulate the arrival/ service pattern for a ten day period and estimate the mean number of automobiles that remain in service for more than a day. (Use the random numbers: 09, 54, 42, 01, 80, 06, 26, 67, 79, 49, 16, 36, 76, 68, 91, 97, 85, 56, 84. Use the first ten for arrivals and the next ten for service).	**10**	**CO3**
SECTION B (40 Marks)			

(Solve any TWO questions)

Q 7 A machine operator has to perform three operations, namely plane turning, step turning and taper turning on a number of different jobs. The time required to perform these operations in minutes for each operating for each job is given in the matrix given below. Find the optimal sequence, which minimizes the time required.

Job.	*Time for plane turning In minutes*	*Time for step turning in minutes*	*Time for taper turning. in minutes.*
1	3	8	13
2	12	6	14
3	5	4	9
4	2	6	12
5	9	3	8
6	11	1	13

20 **CO3 CO4**

Q8 The estimates of time in weeks of the activities of a project are as follows:

Activity	Predecessor Activity	Optimistic estimate of time	Most likely estimate of time	Pessimistic estimate of time
A	-	2	4	6
B	A	8	11	20
C	A	10	15	20
D	B	12	18	24
E	C	8	13	24
F	C	4	7	16
G	D,F	14	18	28
H	E	10	12	14
I	G,H	7	10	19

i. Determine the critical activities and the project completion time using PERT.

ii. Calculate event, total, free and independent floats for all activities.

20 **CO3 CO4**

Q9 A glass factory specializing in crystal is developing a substantial backlog and the firm's management is considering three courses of action: (S_1) arrange for sub-contracting, (S_2) construct new facilities. The correct choice depends largely upon future demand which may be low, medium, or high. By consensus, management ranks the respective probabilities as 0.10, 0.50 and 0.40. A cost analysis reveals the effect upon the profits that

20 **CO3 CO4**

	is shown in the table. Show this decision situation is in the form of a decision tree and indicates the most preferred decision and corresponding expected value.		

Profit (Rs. '000) If demand is	Courses of action		
	S_1 (Subcontracting)	S_2 (Overtime)	S_3 (Construct facilities)
Low (p = 0.10)	10	-20	-150
Medium (p = 0.50)	50	60	20
High (p = 0.40)	50	100	200

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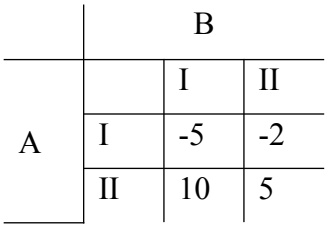
SECTION A (60 marks)

Sl. No.			Marks	CO
Q1	i.	If the value of the game is zero, then the game is known as: (a) Fair strategy, (b) Pure strategy, (c) Pure game, (d) Mixed strategy.	**10x1=10**	**CO1**
	ii.	For the payoff matrix the player A always uses:  (a) First strategy (b) Mixed strategy of both II and I (c) Does not play game (d) Second strategy.		
	iii.	Traffic intensity is given by: (a) Mean arrival rate / Mean service rate, (b) $\lambda \times \mu$, (c) μ/λ, (d) Number present in the queue/Number served		
	iv.	To solve degeneracy in the transportation problem we have to: (a) Put allocation in one of the empty cells as zero, (b) Put a small element epsilon in any one of the empty cells, (c) Allocate the smallest element epsilon in such a cell, which will not form a closed loop with other loaded cells, (d) Allocate the smallest element epsilon in such a cell, which will form a closed loop with other loaded cells		
	v.	In Hungarian method of solving assignment problem, the row opportunity cost matrix is obtained by: (a) Dividing each row by the elements of the row above it, (b) Subtracting the elements of the row from the elements of the row above it, (c) Subtracting the smallest element from all other elements of the row, (d) Subtracting all the elements of the row from the highest element in the		

		B	
		I	II
A	I	-5	-2
	II	10	5

matrix.

vi. To convert ≤ type of inequality into equations, we have to
(a) Assume them to be equations, (b) Add surplus variables,
(c) Subtract slack variables. (d) Add slack variables.

vii. To convert 'n' jobs and 3-machine problem into 'n' jobs and 2-machine problem, the following rule must be satisfied.
(a) All the processing time on second machine must be same.
(b) The maximum processing time of 2nd machine must be ≤ to minimum processing times of first and third machine.
(c) The maximum processing time of 1st machine must be ≤ to minimum processing time of other two machines.
(d) The minimum processing time of 2nd machine must be ≤ to minimum processing times of first and third machine

viii. The assignment problem will have alternate solutions
(a) when total opportunity cost matrix has at least one zero in each row and column, (b) When all rows have two zeros,
(c) When there is a tie between zero opportunity cost cells,
(d) If two diagonal elements are zeros

ix. As per queue discipline the following is not a negative behavior of a customer:
(a) Balking, (b) Reneging, (c) Boarding, (d) Collusion

x. When the operating characteristics of the queue system is dependent on time, it is said to be: (a) Steady state, (b) Explosive state, (c) Transient state, (d) Any one of the above

Q 2

Job	A	B	C	D	E	F	G
Machine M_1	3	8	7	4	9	8	7
Machine M_2	4	3	2	5	1	4	3
Machine M_3	6	7	5	11	5	6	12

Determine the optimal sequence of jobs that minimizes the total elapsed time bases on the following information processing time on machines is given in hours and passing is not allowed:

10 **CO2**

Q 3 A manager has 4 jobs on hand to be assigned to 3 of his clerical staff. Clerical staff differs in efficiency. The efficiency is a measure of time taken by them to do various jobs. The manager wants to assign the duty to his staff, so that the total time taken by the staff should be minimum. The matrix given below shows the time taken by each person to do a particular job. Help the manager in assigning the jobs to the personnel.

10 **CO3**

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<tr><td>Jobs.</td><td colspan="3">Men (time taken to do job in hours).</td></tr>
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</td><td></td><td></td></tr>
<tr><td>Q4</td><td>A and B play a game in which each has three coins, a 5 paise, 10 paise and 20 paise coins. Each player selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount, A wins B's coins. If the sum is even, B wins A's coins. Find the optimal strategies for the players and the value of the game.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q5</td><td>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.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q6</td><td>The automobile company manufactures around 150 scooters. The daily production varies from 146 to 154 depending upon the availability of raw materials and other working conditions:
<table>
<tr><td>Production (per day)</td><td>146</td><td>147</td><td>148</td><td>149</td><td>150</td><td>151</td><td>152</td><td>153</td></tr>
<tr><td>Probability</td><td>0.04</td><td>0.09</td><td>0.12</td><td>0.14</td><td>0.11</td><td>0.10</td><td>0.20</td><td>0.12</td></tr>
</table>
The finished scooters are transported in a specially arranged lorry accommodating 150 scooters. Using following random numbers:
80, 81, 76, 75, 64, 43, 18, 26, 10, 12, 68, 69, 61, 57.
Simulate the process to find out:
(i) What will be the average number of scooters waiting in the factory?
(ii) What will be the average number of empty space on the lorry?</td><td>10</td><td>CO3
CO4</td></tr>
</table>

SECTION B (40 Marks)
(Solve any TWO questions)

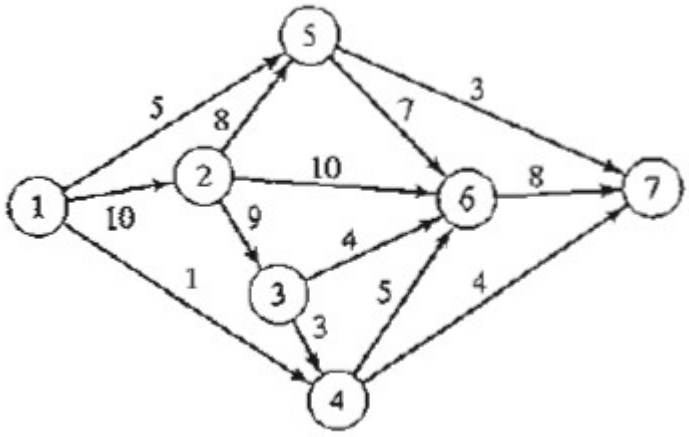
Q7 A machine operator processes five types of items on his machine each week, and must choose a sequence for them. The set-up cost per change depends on the item presently on the machine and the set-up to be made according to the following table:

From item	To item				
	A	B	C	D	E
A	∞	4	7	3	4
B	4	∞	6	3	4
C	7	6	∞	7	5
D	3	3	7	∞	7
E	4	4	5	7	∞

If he processes each type of item once and only once each week, how should he sequence the item on his machine in order to minimize the total set-up cost?

20 **CO3 CO4**

Q8 For the project represented by the network shown in the figure, the estimates (a,m,b) are listed in the table. Determine the project completion time and determine the probability of completing the project with a maximum 10% delay from the estimated project completion time.



Activity	(a, m, b)	Activity	(a, m, b)
1-2	(5, 6, 8)	3-6	(3, 4, 5)
1-4	(1, 3, 4)	4-6	(4, 8, 10)
1-5	(2, 4, 5)	4-7	(5, 6, 8)
2-3	(4, 5, 6)	5-6	(9, 10, 15)
2-5	(7, 8, 10)	5-7	(4, 6, 8)
2-6	(8, 9, 13)	6-7	(3, 4, 5)
3-4	(5, 9, 19)		

20 **CO3 CO4**

Q9	A large steel manufacturing company has three options with regard to production: (i) produce commercially (ii) build pilot plat (iii) 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.	**20**	**CO3 CO4**