(Pages : 6) **L – 5080**

Reg. No. : ....

Name : ....

Fifth Semester B.Tech. Degree Examination, March 2021

13.502 – ENGINEERING MATHEMATICS – V (FR) (ADVANCED MATHEMATICS AND QUEUEING MODELS)

(2013 Scheme)

Time : 3 Hours Max. Marks : 100

PART – A

Answer **all** questions. Each question carries **4** marks.

1. What are artificial variables in an LPP and why do we need them? How do they differ from slack/surplus variables?

2. Distinguish between degenerate and non-degenerate solutions in LP problems. How do you recognize a degenerate solution while using the Simplex Method?

3. Describe the Vogel's approximation method to find the initial basic feasible solution of a transportation problem.

4. Write any two limitations of Critical Path Method.

5. Explain important elements of a queueing system.

(5 × 4 = 20 Marks)

P.T.O.

PART – B

Answer **one full** questions from each module. Each question carries **20** marks.

Module – I

6. A company produces two products A and B. The sales volume for A is at least 80% of the total sales of A and B. However, the company cannot sell more than 100 units of A per day. Both the products use the same raw material, the maximum daily availability of which is 240 Kg. To produce one unit of A, 2 Kg of raw material is required while one unit of B requires 4 Kg of raw material. The profit per unit for A and B are Rs 20 and Rs 50 respectively. Determine the optimal product mix for the company graphically.

OR

7. Use Big-M method to minimize $z = -3x_1 + x_2 + x_3$

   Subject to

   $$x_1 - 2x_2 + x_3 \leq 11$$
   $$-4x_1 + x_2 + 2x_3 \geq 3$$
   $$2x_1 - x_3 = -1$$
   $$x_1, x_2, x_3 \geq 0.$$

Module – II

8. Using duality solve the LPP

   Minimize $z = 10x_1 + 15x_2 + 30x_3$

   subject to

   $$x_1 + 3x_2 + x_3 \geq 90$$
   $$2x_1 + 5x_2 + 3x_3 \geq 120$$
   $$x_1 + x_2 + x_3 \geq 60$$
   $$x_1, x_2, x_3 \geq 0$$

OR

9. (a) In a Supermarket there are five packing sections to pack five different items. From the past experience the manager has the following information about the hourly rate at which the items are packed by his five employees.

		Employees				
		E_1	E_2	E_3	E_4	E_5
	P_1	32	38	40	28	49
Packing sections	P_2	40	24	28	21	36
	P_3	41	27	33	30	37
	P_4	22	38	41	36	36
	P_5	29	33	40	35	39

Allocate the packing sections to employees such that each employee gets exactly one section and maximum packing is done in an hour.

(b) A factory manufacturing television sets has three plants and four depots. The daily production at the plants P_1, P_2 and P_3 are 130. 150 *and* 170 TV sets respectively. The requirements at the depots D_1, D_2, D_3 and D_4 are 90, 100, 140, 120 respectively The cost of shipping one TV set from each plant to each depot is given below. Find the minimum transportation cost.

		Depots			
		D_1	D_2	D_3	D_4
	P_1	10	12	15	8
Plants	P_2	14	11	9	10
	P_3	20	5	7	18

Module – III

10. (a) State Fulkerson's rule for numbering the nodes in a network.

(b) A project consists of a series of tasks labelled $A, B, \ldots H, I$ with the following relationships $A < D, A < E, B < F, D < F, C < G, C < H, F < I, G < I$.

($W < X$ means that X cannot start until W is completed)

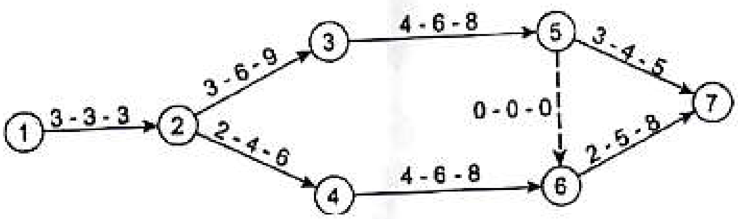
Construct the network diagram. Find also the minimum time for completion of the project, when the time (in days) of completion of each task is as follows:

Task	A	B	C	D	E	F	G	H	I
Time	23	8	20	16	24	18	19	4	10

OR

11. (a) Explain the method of determining the probability of completing a project in a given time.

(b) A PERT network is given below. The completion time estimates in weeks are mentioned in the figure.



(i) Calculate the expected duration and variance of the critical path.

(ii) What is the probability that the jobs on the critical path will be completed in 161 days?

Module – IV

12. (a) Customers arrive to a telephone booth according to a Poisson distribution. The average time between two consecutive arrivals is 9 minutes. The time a customer takes to complete his call is exponentially distributed with mean 3 minutes.

(i) Determine the probability that the person arriving at the booth will have to wait.

(ii) The telephone company will install a second booth if a customer is expected to wait at least 4 minutes for the phone. Find the increase in arrival rate which will justify the second booth.

(iii) What is the probability that a customer has to wait more than 10 minutes to get the phone?

(iv) Find the fraction of a day that the phone will be in use.

(b) In a shop there are two salesmen to attend the customers. The service time for each customer is exponentially distributed with mean 4 minutes. The arrival of customers to the shop is in a Poisson fashion at the rate of 10 per hour.

(i) What is the probability that an arriving customer has to wait for service?

(ii) What is the expected percentage of idle time for each salesman?

(iii) What is the expected number of customers in the shop?

OR

13\. (a) Determine the minimum number of parallel servers in each of the *(M/M/C)* : *(∞/FIFO)* queues so that the system is stable.

(i) Customers arrive at every 5 minutes and are served at the rate of 10 per hour.

(ii) The average time between the arrivals of two consecutive customers is 2 minutes and the average time taken for the completion of a service is 10 minutes.

(iii) Customers arrive at a rate of 10 per hour and served at a rate of 3 per hour

(iv) Customers arrive at a rate of 6 per hour and the average service time is 24 minutes.

(b) A bank has two counters for cash withdrawals: One for withdrawals below Rs.30,000/- and the other for Rs.30,000/- and above. The service time at each of the counters is distributed exponentially with a mean of 6 minutes. The arrival of customers to both the counters are in a Poisson fashion. On the average 8 customers arrive to withdraw amount below Rs.30,00/- in an hour while the arrival rate for the other counter is 5 per hour.

(i) Find the average waiting time of each type of customers.

(ii) If each counter can handle all withdrawals irrespective of their values, how will the average waiting time change?

($4 \times 20 = 80$ Marks)

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