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**Bihar Engineering University, Patna**  
**End Semester Examination - 2022**

**Course: B.Tech.**  
**Code: 102706**

**Semester: VII**  
**Subject: Operation Research**

**Time: 03 Hours**  
**Full Marks: 70**

**Instructions:-**

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory

**Q.1 Choose the correct answer any seven of the following:**

**[2 x 7 = 14]**

- (a) In a transportation problem with 4 supply points and 5 demand points, how many number of constraints are required in its formulation?
  - I. 20
  - II. 1
  - III. 0
  - IV. 9
- (b) Consider the Linear Programming problem:  
Maximize:  $7X_1 + 6X_2 + 4X_3$  subject to:  
 $X_1 + X_2 + X_3 \leq 5$ ;  
 $2X_1 + X_2 + 3X_3 \leq 10$ ;  
 $X_1, X_2, X_3 \geq 0$  (Solve by algebraic method).  
The number of basic solutions is:
  - I. 10
  - II. 7
  - III. 9
  - IV. 8
- (c) A constraint in an LP model becomes redundant because
  - I. Two iso-profit lines may be parallel to each other
  - II. The solution is unbounded
  - III. The constraint is not satisfied
  - IV. None of the above
- (d) ABC analysis in materials management is a method of classifying the inventories based on
  - I. The value of annual usage of the items
  - II. Economic order quantity
  - III. Volume of material consumption
  - IV. Quantity of materials used
- (e) In queuing theory, the ratio of mean arrival rate and the mean service rate is termed as:-
  - I. Work factor
  - II. Utilization factor
  - III. Slack constant
  - IV. Production rate
- (f) If the number of arrival in a queue follows the poisson distribution then the inter arrival time obeys which one of the following distributions
  - I. Poissons distribution
  - II. Negative exponential law
  - III. Normal distribution
  - IV. Binomial distribution
- (g) In PERT the distribution of activities times is assumed to be
  - I. Normal
  - II. Gamma
  - III. Beta

IV. Exponential

- (h) A PERT network has 9 activities on its critical path. The standard deviation of each activity on the critical path is 3. The standard deviation of the critical path is
- 3
  - 9
  - 81
  - 27

- (i) Hungarian Method is used to solve
- A transportation problem
  - A travelling salesman problem
  - A LP problem
  - Both a & b
- (j) In queuing models, M/M/c denotes a Poisson arrival process and
- Exponentially distributed service times and c servers in series
  - Constant service times and servers in series
  - Exponentially distributed service times and c servers in parallel
  - Constant service times and c servers in parallel

**Q.2** (a) Answer the following questions: [7]

Use the Big-M method to solve the LP problem.

$$\text{Minimize } Z = 3X_1 + 4X_2$$

Subject to the constraints (i)  $2X_1 + 3X_2 \geq 8$  (ii)  $5X_1 + 2X_2 \geq 12$  and  $X_1, X_2 \geq 0$

- (b) Arrivals at a telephone booth are considered to be Poisson at an average time of 8 min between one arrival and the next. The length of the phone call is distributed exponentially, with a mean of 4 min. Determine. [7]
- Expected fraction of the day that the phone will be in use
  - Expected number of units in the queue
  - Expected waiting time in the queue.
  - Expected number of units in the system.

**Q.3** (a) What is crashing in network and explain the meaning of cost slope in crashing of network. [4]

(b) A Project has activities with the following normal and crash times and cost: [10]

Activity	Predecessor Activity	Normal Time (Weeks)	Crash Time (Weeks)	Normal Cost (Rs.) x 1000	Crash Cost (Rs.) x 1000
A	-	4	3	8	9
B	A	5	3	16	20
C	A	4	3	12	13
D	B	6	5	34	35
E	C	6	4	42	44
F	D	5	4	16	16.5
G	E	7	4	66	72
H	G	4	3	2	5

Determine a crashing scheme for the above project so that the total project time is reduced by 3 weeks.

**Q.4** (a) What are the limitations of OR. [2]

(b) Explain the terms Arrival pattern, Service discipline, Service Channel, Service distribution. [4]

(c) In a Supermarket, the average arrival rate of customers is 10 every 30 minutes, following Poisson process. The average time taken by a cashier to list and calculate the customer's purchase is two and a half minutes following exponential distribution. What is the probability that the queue length exceeds six? What is the expected time spent by a customer in the system? [8]



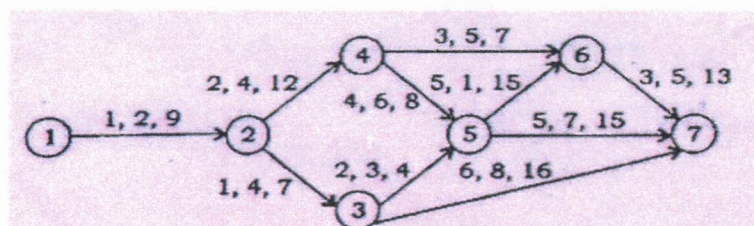
- Q.5** (a) Four technicians are required to perform four different jobs. Assign the job to technician to minimize the total work time. [7]

20	36	31	27
24	34	45	22
22	45	38	18
27	40	35	28

- (b) Luminous lamps have three factories- $F_1$ ,  $F_2$  and  $F_3$  with production capacity 30, 50 and 20 units per week respectively. These units are to be shipped to four warehouses  $W_1$ ,  $W_2$ ,  $W_3$ , and  $W_4$  with requirement of 20, 40, 30 and 10 units per week respectively. The transportation costs (in Rs. Per unit between factories and warehouses are given below. Find an initial basic feasible solution of the given transportation problem using north-west corner rule. [7]

Factory	$W_1$	$W_2$	$W_3$	$W_4$	Supply
$F_1$	1	2	1	4	30
$F_2$	3	3	2	1	50
$F_3$	4	2	5	9	20
Demand	20	40	30	10	

- Q.6** (a) Distinguish between PERT and CPM. What is critical path? [4]  
 (b) Consider the network shown in the figure below: [10]



The estimate  $t_o$ ,  $t_m$  and  $t_p$  are shown in this order for each of the activities on the top of the edges denoting the respective activities. Calculate:

- Variance to each activity
- Critical path and expected project length;
- The probability of completing the project in 25 days

Given that

Z value	:	0.61	0.62	0.63	0.64	0.65
Probability	:	0.2291	0.2324	0.2357	0.2389	0.2422

- Q.7** Explain in detail about Kendall's Notation. A medical store has one cashier who collect cash. The cashier can serve on an average 20 customers per hour. Who arrive at his counter randomly at the rate of 18 on an average per hour. The management of the store notice that the cashier was idle some of the time, but at times long queues form at his counter and the customer complaints about waiting are increasing. It was therefore decided to investigate the following: [14]

- What portion of time the cashier is likely to be idle?
- What is the average length of the waiting line to expected under the existing service condition?
- How many customers would be expected to be in the service area (i.e. in line and being served)?

Q.8 (a) Explain briefly ABC analysis in material management.

[6]

- (b) A manufacturer operates three factories from which items are shipped to four warehouses. Factory to warehouse shipping cost in quantities available at each of the factories X, Y and Z and requirements at each of the warehouses A, B, C and D are given in the table below:

[8]

Factory	Warehouses				Quantity Available
	A	B	C	D	
X	20	30	50	17	7
Y	70	35	40	60	10
Z	40	12	60	25	18
Quantity Required	5	8	7	15	

Determine initial feasible solution by

- (i) North-West corner method
- (ii) Vogel's Approximation

Q.9 (a) Define various types of solutions obtained in LPP

[7]

- (b) Explain degeneracy in transportation problem.

[7]

