SEE EXAM U.S.N. | | | | | | | | | | |

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

April / May 2022 Semester End Main Examinations

Programme: B.E.
Branch: CSE/ISE
Course Code: 19MA3BSSDM
Course: STATISTICS AND DISCRETE MATHEMATICS

Semester: III
Duration: 3 hrs.
Max Marks: 100
Date: 25.04.2022

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Statistical tables is permitted.

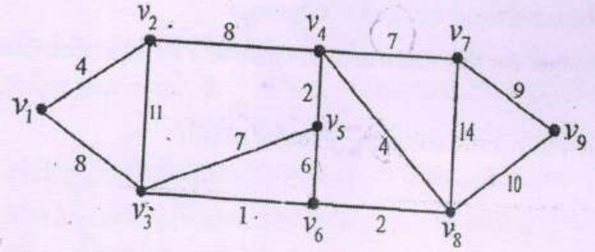
Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) Prove that a connected graph G remains connected even after removing an edge e from G if and only if e is a part of some cycle in G. **6**

b) Define the incidence matrix with an example. Also, write any four observations on the incidence matrix. **7**

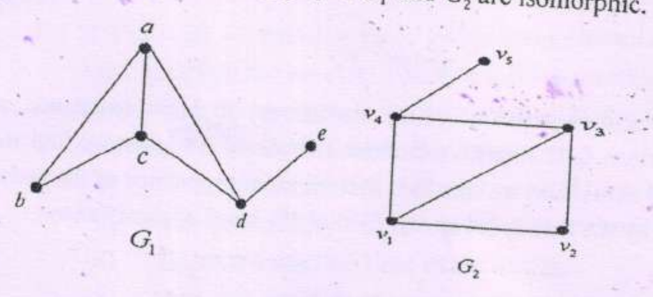
c) Using Kruskal's algorithm, find the minimum spanning tree of the graph given below. **7**



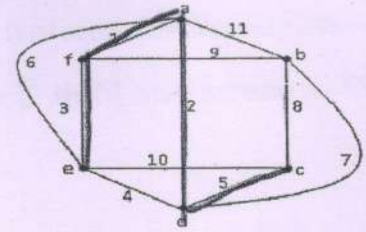
OR

2 a) For a graph with n vertices and m edges if δ is the minimum and Δ is the maximum of the degrees of the vertices, show that $\delta \le \frac{2m}{n} \le \Delta$. **6**

b) Show that the following graphs G_1 and G_2 are isomorphic. **7**



c) Apply Prim's algorithm to find the minimum spanning tree of the graph given below. 7



UNIT - II

3 a) At a restaurant, 10 men hand over their umbrellas to the receptionist. In how many ways can their umbrellas be returned so that (i) no man receives his own umbrella? (ii) at least one of the men receives his own umbrella? (iii) at least two of the men receive their own umbrella? 6

b) Determine the number of positive integers n such that $1 \leq n \leq 100$ and n is not divisible by 2, 3 or 5. 7

c) Determine the coefficient of $x^2y^2z^3$ in the expansion of $(3x-2y-4z)^7$. 7

UNIT - III

4 a) The life time of a certain kind of battery is a random variable which has exponential distribution with a mean of 200 hours. Find the probability that such a battery will 6

i) last at most 100 hours.
ii) last anywhere between 400 and 600 hours.

b) Derive an expression for the mean and variance of a Poisson distribution with parameter λ. 7

c) For the given bivariate probability distribution, obtain 7

i) Marginal probabilities of X, Y.
ii) Mean of X, Y.
iii) Variance of X, Y.

X \ Y	5	10
0	0.1	0.2
1	0.2	0.4
2	0.1	0

UNIT - IV

5 a) A firm manufactures resistors which are known to have resistance with standard deviation 0.02 ohms. A random sample of 64 resistors had mean resistance 1.39 ohms. Can we conclude that the mean resistance of the resistors manufactured by the firm is 1.4 ohms? Test at 5% level of significance. 6

b) 500 articles from a factory are examined and found to be 2% defective. 800 similar articles from a second factory are found to have only 1.5% defective. Can it be reasonable to conclude that the products of the first factory are inferior to those of the second. Test at 5% level of significance. 7

c) The nine items of a sample have the following values: 45, 47, 50, 52, 48, 47, 49, 53 and 51. Does the mean of these differ significantly from the assumed mean of 47.5? Test at 5% level of significance. 7

OR

6 a) The number of accidents per day were studied for 144 days in the city Bangalore and for 100 days in the city Delhi. The mean number of accidents and the standard deviation were respectively 4.5 and 1.2 for the Bangalore city and 5.4 and 1.5 for the Delhi city. Is the city Bangalore more prone to the accidents than the city Delhi? Test at 5% level of significance. 6

b) It was found that a machine has produced pipes having 0.5 mm thickness. To determine whether the machine is in proper working order, a sample of 10 pipes are chosen, for which the mean thickness is 0.53 mm and standard deviation is 0.03mm. Test the hypothesis that the machine is in proper working condition using 1% level of significance. 7

c) Two samples of sizes 9 and 8 give the sum of squares of deviations from their respective means equal to 160 square inches and 91 square inches respectively. Can these be regarded as drawn from the same normal populations with equal variances? Test at 5% level of significance. 7

UNIT - V

7 a) Show that $P = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.5 & 0.5 & 0 \end{bmatrix}$ is a regular stochastic matrix. Also find the unique fixed probability vector. 6

b) The transition probability matrix of a Markov chain having three states 1, 2, 3 is $P = \begin{bmatrix} 0.2 & 0.3 & 0.5 \\ 0.1 & 0.6 & 0.3 \\ 0.4 & 0.3 & 0.3 \end{bmatrix}$ and the initial probability distribution vector is $p^{(0)} = [0.5 \;\; 0.3 \;\; 0.2]$. Find the higher transition probability matrix $p^{(1)}, p^{(2)}, p^{(3)}$. 7

c) In a railway marshaling yard, goods train arrives at the rate of 30 trains/day. Assuming that the inter-arrival time follows an exponential distribution and the service time(time taken to hump a train) distribution is also exponential with an average 36 min. Calculate the following : 7

i) Average number of trains in the yard
ii) The probability that the queue size exceeds 9.
iii) Expected waiting time in the queue.
iv) Average number of trains in the queue.

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Course Statistics & discrete mathem Course Code 19MA3BSSDM

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Date SCHEME OF VALUATION Date

Q. No.		Marks
1 (a)	suppose e is a part of some cycle c of G. Then the end vertices of e (say a & b) are joined by atleast two paths one of which is e & other is c-e. Hence removal of e from G, will not affect connectivity of G, because even after removal of e, the end vertices of e remains connected.	3
	Conversely suppose e is not a part of cycle in G, then end vertices of e are connected by atmost one path. Hence removal of e from G disconnects these end points ∴ G-e is disconnected graph. Thus if e is not a part of any cycle in G then G-e is disconnected	3
1 (b)	Given a graph G without self loops, we define incidence matrix $A = [a_{ij}]$ of order $n \times m$ as follows $a_{ij} = 1$ if edge e_j incident on vertex v_i in G $= 0$ otherwise	2 1
	Eg (1) since each edge contains exactly two end vertices, each column contains 1's in exactly two places (2) sum of 1's in each row represent degree of a vertex (3) A row with all zero's represent isolated vertex (4) Two identical columns represent parallel edges	4

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Q. No.		Marks

1c

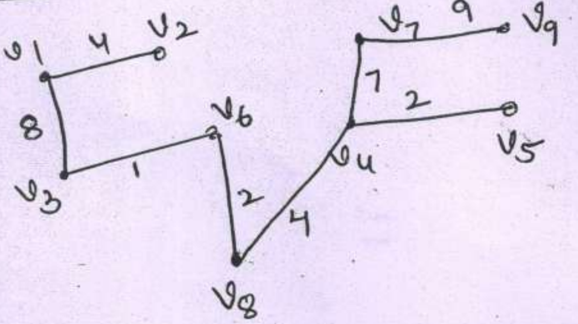
edges	v_3v_6	v_4v_5	v_6v_8	v_1v_2	v_4v_8	v_5v_6	v_3v_5	v_4v_7	v_1v_3	v_2v_4	v_7v_9
wgts	1	2	2	4	4	6	7	7	8	8	9
selection	✓	✓	✓	✓	✓	✗	✗	✓	✓	✗	✓

5

edges	v_8v_9	v_2v_3	v_7v_8
wgts	10	11	14
selec	✗	✗	✗

2

T:



$w(T) = \cancel{\ } 37$

} 1

2a) Let $v_1, v_2, \ldots, v_n$ be n vertices of graph G which has m edges. then

$d(v_1), d(v_2), \ldots, d(v_n) \geq \delta$ & $d(v_1), d(v_2) \ldots d(v_n) \leq \Delta$ → 1 + 1

By HSP; $d(v_1) + d(v_2) + \ldots + d(v_n) = 2m$ → 1

$2m \geq n\delta$ ∴ $\delta \leq \frac{2m}{n}$ → 1 + 1

$|||^{ly}$ ~~d(v)~~ $2m \leq n\Delta$; $\frac{2m}{n} \leq \Delta$

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Date: 31/3/2022   **SCHEME OF VALUATION**   Date:

Q. No.		Marks
b)	$\lvert V(G_1)\rvert = \lvert V(G_2)\rvert = 5$	
	$\lvert E(G_1)\rvert = \lvert E(G_2)\rvert = 6$	
	Also deg. sequence of G_1 = deg. sequence of G_2	3m
	Define a function $f: V(G_1) \to V(G_2)$ as	
	$f(a) = v_1$, $f(b) = v_2$, $f(c) = v_3$, $f(d) = v_4$	
	& $f(e) = v_5$ Then f is 1-1, onto	2m
	& $ab \leftrightarrow f(a)f(b) = v_1v_2$	
	$ac \leftrightarrow f(a)f(c) = v_1v_3$	
	$ad \leftrightarrow v_1v_4$	
	$bc \leftrightarrow v_2v_3$	
	$cd \leftrightarrow v_3v_4$	
	$de \leftrightarrow v_4v_5$	
	$\Rightarrow$ adjacency of vertices is preserved $\therefore G_1 \cong G_2$	2m
c)	In Graph G, an edge $(v_1 v_2)$ has min weight	
	Let T':  , $E' = \{(v_1, v_2)\}$, $V' = \{v_1, v_2\}$	
	$V' \neq V(G)$. Now v_4 is the vertex in $V(G)$ which is	
	adj to v_1 that is not in V' and $w(v_1 v_4) = 2$	
	Illy v_3 and v_5 are the vertices in $V(G)$ which are adjacent	
	to v_2 and are not in V' with $w(v_2 v_3) = 2$, $w(v_2 v_5) = 1$	

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Date: **SCHEME OF VALUATION** Date:

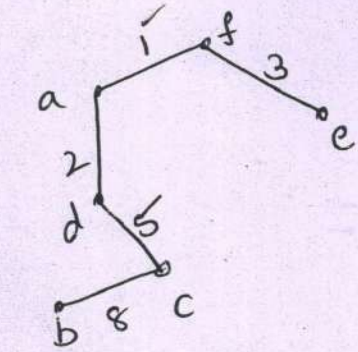
Q. No.		Marks

2C

	a	b	c	d	e	f
→ a	–	11	∞	$\boxed{2}$	6	$\boxed{1}$
b	11	–	$\boxed{8}$	7	∞	9
c	∞	8	–	5	10	∞
→ d	2	∞	5	–	4	∞
e	6	∞	10	4	–	$\boxed{3}$
→ f		9	∞	∞	3	–

→ 5

T :



$\omega(T) = 19$

→ 2

3a

No man receives his own umbrella $= d_{10} = 1335036$ → 2

Atleast one of the men receives his own umbrella 2

$= 10! - d_{10} = 2293764$

Atleast two of the men receives their own umbrella 2

$= 10! - d_{10} - 10d_9 = 958724$

3b

$|S| = N = 100$

Let C_1, C_2, C_3 be set of integers such that n is divisible by 2, 3, 5 resply

$N(C_1) = 50$; $N(C_2) = 33$, $N(C_3) = 20$

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Date: 31/03/2022   **SCHEME OF VALUATION**   Date:

Q. No.		Marks
	$N(C_1 C_2) = 16, \quad N(C_1 C_3) = 10, \quad N(C_2 C_3) = 6$	
	$N(C_1 C_2 C_3) = 3$	3m
	∴ No. of +ve Integers which are not divisible by 2, 3 or 5 are	
	$N(\overline{C_1 \cup C_2 \cup C_3}) = N - N(C_1 \cup C_2 \cup C_3)$	
	$= 100 - (N(C_1) + N(C_2) + N(C_3) - N(C_1 C_2) - N(C_2 C_3) - N(C_1 C_3) + N(C_1 C_2 C_3))$	
	$= 100 - (50 + 33 + 20 - 16 - 16 - 6 + 3) = 26$	4m
c)	The general term in the expansion of	
	$(3x - 2y - 4z)^7$ is $\binom{7}{n_1, n_2, n_3} (3x_1)^{n_1} (-2y)^{n_2} (-4z)^{n_3}$	4m
	For $n_1 = 2, n_2 = 2, n_3 = 3$, this becomes	
	$\binom{7}{2, 2, 3} (3^2 \times (-2)^2 \times (-4)^2 (x^2 y^2 z^3)$	3m
	∴ The required coeff. is $3^2 (-2)^2 (-4)^3 \binom{7}{2\ 2\ 3}$	
	$= -9 \times 4 \times 64 \times \frac{7!}{2!\, 2!\, 3!} = -4,83,840$	3m

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31/03/2022

Date: CSE / ISE **SCHEME OF VALUATION** Date:

Q. No.		Marks
4 a)	Let X denote the life time of batteries, then X follows an exponential distribution with $\sigma = 200$ hrs	
	$\therefore$ p.d.f of X is $P[X=x] = f(x) = \frac{1}{\sigma} e^{-\frac{x}{\sigma}} = \frac{1}{200} e^{-\frac{x}{200}}$	2M
	i) P[battery will last atmost 100 hrs]	
	$= P[X \le 100] = \int_0^{100} \frac{1}{200} e^{-\frac{x}{200}} dx = \frac{1}{200} \left. \frac{e^{-\frac{x}{200}}}{-\frac{1}{200}} \right\|_0^{200}$	
	$= 1 - e^{-0.5} = 0.393$	2M
	ii) P[battery will last anywhere bet 400 & 600 hrs]	
	$= P[400 \le X \le 600] = \frac{1}{200} \int_{400}^{600} e^{-\frac{x}{200}} dx$	
	$= \frac{1}{200} \left[\frac{e^{-\frac{x}{200}}}{-\frac{1}{200}} \right]_{400}^{600} = e^{-2} - e^{-3}$	2M
b)	Let X be a Poisson variate with parameter λ	
	$p(x) = \frac{e^{-\lambda} \lambda^x}{x!}, \quad x = 0, 1, 2 \ldots$	
	$E(X) = \text{Mean} = \sum_x x\, p(x)$	
	$= \sum_{x=0}^{\infty} x \frac{e^{-\lambda} \lambda^x}{x!} = 0 + \sum_{x=1}^{\infty} x \frac{e^{-\lambda} \lambda^x}{x (x-1)!}$	
	$= e^{-\lambda} \lambda \sum_{x=1}^{\infty} \frac{\lambda^{x-1}}{(x-1)!} = e^{-\lambda} \lambda (e^{\lambda}) = \lambda$	3M

$$E(x(x-1)) = \sum_{x=0}^{\infty} x(x-1)\frac{e^{-\lambda}\lambda^{x}}{x!}$$

$$= 0 + \sum_{x=2}^{\infty} x(x-1)\frac{e^{-\lambda}\lambda^{2}\lambda^{x-2}}{x(x-1)(x-2)!}$$

$$= e^{-\lambda}\lambda^{2}\sum_{x=2}^{\infty}\frac{\lambda^{x-2}}{(x-2)!}$$

$$= e^{-\lambda}\lambda^{2}e^{\lambda} = \lambda^{2}$$

$$\therefore E(X(X-1)) = E(X^2) - E(X) = \lambda^2$$

$$\Rightarrow E(X^2) = \lambda^2 + E(X) = \lambda^2 + \lambda$$

$$V(X) = E(X^2) - (E(X))^2 = \lambda^2 + \lambda - \lambda^2 = \lambda$$ 4M

c) i) Marginal dist of X:

x	0	1	2
$p_X(x)$	0.3	0.6	0.1

Marginal dist of Y:

y	5	10
$p_Y(y)$	0.4	0.6

2M

$E(X) = \sum x p_X(x) = 0\times0.3 + 1\times0.6 + 2\times0.1 = 0.8$

$E(Y) = \sum y p_Y(y) = 5\times0.4 + 10\times0.6 = 8$ 2M

$E(X^2) = \sum x^2 p_X(x) = 0\times0.3 + 1^2\times0.6 + 2^2\times0.1 = 1$

$E(Y^2) = \sum y^2 p_Y(y) = 5^2\times0.4 + 10^2\times0.6 = 70$

Variance of $X = E(X^2) - (E(X))^2 = 1 - (0.8)^2 = 0.36$

Variance of $Y = E(Y^2) - (E(Y))^2 = 70 - 8^2 = 6$ 3M

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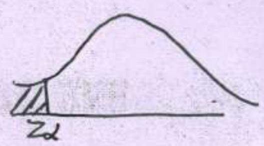
Date: 31/03/2022 **SCHEME OF VALUATION** Date:

Q. No.		Marks
5a)	$\mu_0 = 1.4$ ohms, $\sigma = 0.02$ ohms, $n = 64$, $\bar{x} = 1.39$	
	H_0: The mean resistance of the resistors $= 1.4$ ohm	
	H_1: The mean resistance of the resistors $\neq 1.4$ ohms	1m
	Test statistic $= \lvert z\rvert_{cal} = \dfrac{\lvert\bar{x} - \mu_0\rvert}{\frac{\sigma}{\sqrt{n}}}$	1m
	$= \dfrac{\lvert 1.39 - 1.41\rvert}{\frac{0.02}{\sqrt{64}}} = 4$	1m
	α at 5%, $K = 1.96$, $\lvert z\rvert_{cal} > k$ $\therefore H_0$ is rejected	2M
	Conc: The mean resistance of the resistors is not equal to 1.4 ohms	1m
b)	$n_1 = 500$, $n_2 = 800$,	
	Proportion of defectives in first factory $= p_1 = 0.02$	
	& in the second factory $p_2 = 0.015$	
	Proportion of the population $P = \dfrac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = 0.017$	
	$Q = 1 - P = 0.983$	1M
	H_0: $p_1 \geq p_2$ or ($p_1 = p_2$) i.e. Products do not differ in quality	1M
	H_1: $P_1 < P_2$	
	$\lvert z\rvert_{cal} = \dfrac{\lvert p_1 - p_2\rvert}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \dfrac{\lvert 0.02 - 0.015\rvert}{\sqrt{0.017 \times 0.983\left(\frac{1}{500} + \frac{1}{800}\right)}}$	

$= 0.67$  2M

At $\alpha = 5\%$, accept H_0 when $Z > Z_\alpha$ 2M

~~$|k$ at $\alpha = 5\%$ is 1.96~~

$Z_\alpha = -1.65$

$\therefore$ ~~$|z|_{cal} \le k \Rightarrow H_0$ is Accepted~~.

Accept H_0, product of first factory not inferior to the second factory

$\therefore$ Conclusion: ~~The two factories are producing similar products which do not differ in quality, Hence~~

~~The product of first factory are inferior to those of second~~ 1M

c) $\bar{x} = \frac{\sum x_i}{n} = 49.1$, $\mu = 47.5$ $\quad H_0: \mu = 47.5$ vs $H_1: \mu \neq 47.5$

Hyp - 1M
$\bar{x}$ - 1M
σ - 1M
t - 1M
t_α - 2M
Conclu - 1M

$s = \sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}} = 2.47$, H_0: There is no significant difference between $\bar{x}$ & μ

$$t_{cal} = \frac{|\bar{x} - \mu|}{\frac{\sigma}{\sqrt{n-1}}}$$

$$= \frac{49.1 - 47.5}{\frac{2.47}{\sqrt{8}}} = 1.83$$ 2m

At $df = 9 - 1 = 8$, $t_{0.05} = 2.31 = t_{tab}$

$t_{cal} < t_{tab}$. $\therefore H_0$ is Accepted

Conc: There is no significant difference between $\bar{x}$ & μ 2m

Hyp - 1M
Z_{cal} - 2M
Z_α - 2M
Concl - 1M

6 a) $n_1 = 144$, $\bar{x}_1 = 4.5$, $\sigma_1 = 1.2$

$n_2 = 100$, $\bar{x}_2 = 5.4$, $\sigma_2 = 1.5$

$H_0: \mu_1 = \mu_2$ That is two cities have the same accidents rates 1m

$H_1: \mu_1 > \mu_2$

$$|Z|_{cal} = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = \frac{|4.5 - 5.4|}{\sqrt{\frac{1.2^2}{144} + \frac{1.5^2}{100}}} = 4.99$$ 2m

At $\alpha = 5\%$, $k = 1.65$, $\therefore$ ~~$|z|_{cal} > k$~~ $Z < Z_\alpha$ $\therefore H_1$ is Accepted

2M
1M

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Q. No. Date: 31/03/2022 **SCHEME OF VALUATION** Date: Marks

b) $\mu = 0.5$, $\bar{x} = 0.53$, $s = 0.03$, $n = 10$

H_0: $\mu = 0.5$ ie the machine is in proper working order.

H_1: $\mu \neq 0.5$ — 1m

Test statistic $t_{cal} = \dfrac{|\bar{x} - \mu|}{\frac{s}{\sqrt{n-1}}} = \dfrac{|0.53 - 0.5|}{\frac{0.03}{\sqrt{9}}} = 3$ — 3m

At $df = 9$, $\alpha = 1\%$, $t_{tab} = 3.25$ — 2M

$\therefore t_{cal} < t_{tab}$ $\therefore H_0$ is Accepted.

$\therefore$ The machine is in proper working condition. — 1m

c) Given $\Sigma(x - \bar{x})^2 = 160$, $\Sigma(y - \bar{y})^2 = 91$

$n_1 = 9$, $n_2 = 8$ H_0: Two population variance are equal — 1m

$s_1^2 = \dfrac{\Sigma(x - \bar{x})^2}{n_1 - 1} = \dfrac{160}{8} = 20$

$s_2^2 = \dfrac{\Sigma(y - \bar{y})^2}{n_2 - 1} = \dfrac{91}{7} = 13$ — 2m

$F_{cal} = \dfrac{s_1^2}{s_2^2} = \dfrac{20}{13} = 1.54$ — 1M

F_{tab} = at $\alpha = 5\%$, at $df_1 = 8$, $df_2 = 7$ is 3.73 — 2M

$F_{cal} < F_{tab}$. $\therefore H_0$ is Accepted. — 1m

$\therefore$ Two samples can be regarded as drawn from same normal populations.

7 a) $P^2 = \begin{bmatrix} 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \\ 0 & 1/2 & 1/2 \end{bmatrix}$, $P^3 = \begin{bmatrix} 1/2 & 1/2 & 0 \\ 0 & 1/2 & 1/2 \\ 1/4 & 1/4 & 1/2 \end{bmatrix}$

$P^4 = \begin{bmatrix} 0 & 1/2 & 1/2 \\ 1/4 & 1/4 & 1/2 \\ 1/4 & 1/2 & 1/4 \end{bmatrix}$ $P^5 = \begin{bmatrix} 1/4 & 1/4 & 1/2 \\ 1/4 & 1/2 & 1/4 \\ 1/8 & 3/8 & 1/2 \end{bmatrix}$

Since all the entries of P^5 are +ve $\Rightarrow$ P is a regular matrix 3m

To find $\vartheta = (x, y, z)$ $\ni$ $x+y+z=1$ & $\vartheta P = \vartheta$.

$\Rightarrow (x \quad y \quad z) \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \end{bmatrix} = (x \quad y \quad z)$

$\Rightarrow \frac{z}{2} = x$, $x + \frac{z}{2} = y$, $y = z$

$\Rightarrow z = 2x$, $y = z = 2x$ 3m

$x+y+z = 1 \Rightarrow x = 1/5$, $y = z = 2/5$

b) $P[X_1 = 1, X_0 = 3] = P[X_1 = 1 | X_0 = 3] P[X_0 = 3] = 0.4 \times 0.2 = 0.08$ 2m

$P[X_2 = 2, X_1 = 1, X_0 = 3] = P[X_2 = 2 | X_1 = 1, X_0 = 3] P[X_1 = 1, X_0 = 3]$

$= P[X_2 = 2 | X_1 = 1] (0.08)$

$= 0.3 \times 0.08 = 0.024$ 2m

$\therefore P[X_3 = 3, X_2 = 2, X_1 = 1, X_0 = 3]$

$= P[X_3 = 3 | X_2 = 2, X_1 = 1, X_0 = 3] P[X_2 = 2, X_1 = 1, X_0 = 3]$

$= P[X_3 = 3 | X_2 = 2] \times 0.024$ 3M

$= 0.3 \times 0.024 = 0.0072$

c Correct Explanation of Queuing system 7m

BMS COLLEGE OF ENGINEERING, BANGALORE -19

(Autonomous Institute, Affiliated to VTU)

Course: Stats & discrete Mathematics Course Code: 19MA3BSSDM

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Date: SCHEME OF VALUATION Date

Q. No.		Marks
7 (b)	$p^{(1)} = p^{(0)} P = [.21 \quad .39 \quad .4]$ $\rightarrow$	2
	$p^{(2)} = p^{(0)} P^2 = (.5 \quad .3 \quad .2)\begin{bmatrix} .27 & .39 & .34 \\ .2 & .48 & .32 \\ .23 & .39 & .38 \end{bmatrix} = [.241 \quad .417 \quad .342]$	2
	$p^{(3)} = p^{(0)} P^3 = (.5 \quad .3 \quad .2)\begin{bmatrix} .229 & .417 & .354 \\ .216 & .444 & .34 \\ .237 & .417 & .346 \end{bmatrix} = [.2267 \quad .4251 \quad .348$	2+1=3
7 (c)	$\rightarrow$	2
	$\lambda = \frac{30}{60 \times 24} = \frac{1}{48}$; $\mu = \frac{1}{36}$ $\rightarrow$	1
	$\rho = \frac{\lambda}{\mu} = 0.75$	
	(1) ave no of trains in the yard $= L_s = \frac{\rho}{1-\rho} = 3$ $\rightarrow$	1
	$\rightarrow$	1
	(2) $P(\geq 10) = \rho^{10} = (.75)^{10} = .056$ $\rightarrow$	1
	(3) $W_q = \frac{\lambda}{\mu(\mu-\lambda)} = 108$ min $\rightarrow$	1
	(4) $L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = 2.25$ trains	

Dr. VEENA JAWALI
Professor & Head, Dept. of Mathematics
B.M.S. College of Engineering
Bull Temple Road, Basavanagudi,
BANGALORE - 560 019.