Question 1 → not included

Question #02

(a)

P =	0	1	2	3	4	5
0	0	0	0	2/3	0	1/3
1	0	0	1	0	0	0
2	1	0	0	0	0	0
3	0	1/4	0	0	3/4	0
4	0	0	1	0	0	0
5	0	1/2	0	0	1/2	0

(i) Classes

1. 0
2. 1
3. 2
4. 3
5. 4
6. 5

} transient

(ii) 1) 0 → 3 → 1 → 2 → 0 (4)
2) 1 → 2 → 0 → 3 → 1 (4)
3) 2 → 0 → 3 → 1 → 2 (4)
4) 3 → 1 → 2 → 0 → 3 (4)
5) 4 → 2 → 0 → 3 → 4 (4)
6) 5 → 1 → 2 → 0 → 5 (4)

(b)

Let working = 0
fail = 1

(i)

$$P = \begin{array}{c} \\ 0 \\ 1 \end{array} \begin{array}{c} \begin{array}{cc} 0 & 1 \end{array} \\ \begin{bmatrix} 0.95 & 0.05 \\ 0.5 & 0.5 \end{bmatrix} \end{array}$$

(ii)

$$\begin{bmatrix} \bar{\Lambda}_0 \\ \bar{\Lambda}_1 \end{bmatrix} = \begin{bmatrix} \bar{\Lambda}_0 & \bar{\Lambda}_1 \end{bmatrix} \times \begin{bmatrix} 0.95 & 0.05 \\ 0.5 & 0.5 \end{bmatrix}$$

$$\begin{bmatrix} \bar{\Lambda}_0 \\ \bar{\Lambda}_1 \end{bmatrix} = \begin{bmatrix} 0.95\bar{\Lambda}_0 + 0.5\bar{\Lambda}_1 \\ 0.05\bar{\Lambda}_0 + 0.5\bar{\Lambda}_1 \end{bmatrix}$$

$$\bar{\Lambda}_0 = 0.95\bar{\Lambda}_0 + 0.5\bar{\Lambda}_1$$
$$\bar{\Lambda}_1 = 0.05\bar{\Lambda}_0 + 0.5\bar{\Lambda}_1$$

$$0.05\bar{\Lambda}_0 - 0.5\bar{\Lambda}_1 = 0 \quad \text{— (A)}$$
$$0.05\bar{\Lambda}_0 - 0.5\bar{\Lambda}_1 = 0 \quad \text{— (B)}$$
$$\bar{\Lambda}_0 + \bar{\Lambda}_1 = 1 \quad \text{— (C)}$$

Solving (A) and (C)

$\Lambda_0 = 0.909$

$\Lambda_1 = 0.090$

Or from calculator

$$P = \begin{bmatrix} 0.909 & 0.0909 \\ 0.909 & 0.0909 \end{bmatrix}$$

(C)

$\lambda = 12$ jobs/sec

$\mu = ?$

$P = \frac{\lambda}{S\mu}$ $\quad \because P = 1$

$\quad \because S = 3$

$1 = \frac{12}{3 \times \mu}$

$\mu = \frac{12}{3}$

$\mu = 4$ jobs/sec

~~Question no#01~~

(d)

D/D/3/100/∞/FCFS

Question no#03

(a) $$P\{\omega = t\} = \sum_{n=0}^{\infty} P^n(1-P) \times P\{S_{n+1} = t\}$$

$$= \sum_{n=0}^{\infty} \left(\frac{\lambda}{\mu}\right)^n \left(1 - \frac{\lambda}{\mu}\right) \times \frac{\mu^{n+1} t^{n+1-1} e^{-\mu t}}{(n+1-1)!}$$

$$= \sum_{n=0}^{\infty} \frac{\lambda^n}{\mu^{n+1}} (\mu - \lambda) \frac{\mu^{n+1} t^n e^{-\mu t}}{n!}$$

$$= (\mu - \lambda) e^{-\mu t} \sum_{n=0}^{\infty} \frac{(\lambda t)^n}{n!}$$

$$= (\mu - \lambda) \cdot e^{-\mu t} e^{\lambda t}$$

$$= (\mu - \lambda) \cdot e^{-(\mu-\lambda)t}$$

$$= \int_t^{\infty} (\mu - \lambda) e^{-(\mu-\lambda)t}$$

$$= (\mu - \lambda) \int_t^{\infty} e^{-(\mu-\lambda)t} dt$$

$$= (\mu - \lambda) \frac{e^{-(\mu-\lambda)t}}{-(\mu-\lambda)} \Big|_t^{\infty}$$

$$= - [e^{-\infty} - e^{-(\mu-\lambda)t}]$$

$$= e^{-(\mu-\lambda)t}, \quad t > 0$$

(b)

$\lambda = 180$ packets/sec

$\frac{1}{\mu} = 2.5$ msec

$\mu = \frac{1}{2.5 \times 10^{-3}} = 400$ sec

(i)

$P\{x > 2\} = ?$

$= 1 - P\{x \leq 2\}$

$= 1 - \{P_0 + P_1 + P_2\}$

$P = \frac{\lambda}{\mu} \quad = P = 0.45$

$P_0 = (1 - P)$

$P_0 = 0.55$

$P_1 = \frac{\lambda}{\mu}(1 - P)$

$= 0.2475$

$P_2 = \frac{\lambda^2}{\mu^2}(1 - P)^2$

$P_2 = 0.0612$

$= 1 - \{0.55 + 0.2475 + 0.0612\}$

$P\{x > 2\} = 0.1413$

(ii) $W = \frac{1}{\mu - \lambda}$

$= \frac{1}{400 - 180}$

$= 4.545 \text{ msec}$

(iii) $W_q = \frac{\lambda}{\mu(\mu - \lambda)}$

$= \frac{180}{400(400 - 180)}$

$W_q = 2.045 \text{ msec}$

(iv) $L = \frac{\lambda}{\mu - \lambda}$

$= 0.8182$

(v)

$$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)}$$

$$= 0.3682$$

(vi)

$$T_w(\gamma) = F(w) \times \ln\left(\frac{100}{100-\gamma} \times P\right)$$

$$= (4.545 \times 10^{-3}) \times \left(\ln\left(\frac{100}{100-90} \times 0.4\right)\right.$$

$$T_w(\gamma) = 6.836 \times 10^{-3}$$

Question #04

(a)

$$\lambda = 12/5 = 2.4/\text{min}$$

$$= \frac{2.4}{60} = 0.04 \text{ sec}$$

$$a = 3 \quad , \quad b = 36$$

$$\frac{1}{\mu} = \frac{a+b}{2} = \frac{3+136}{2} = 19.5$$

$$\mu = \frac{1}{19.5} = 0.0512 \text{ per sec}$$

(i) $$\sigma^2 = \frac{(b-a)^2}{12}$$

$$\sigma^2 = 90.75$$

(ii) $$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)}$$

15)

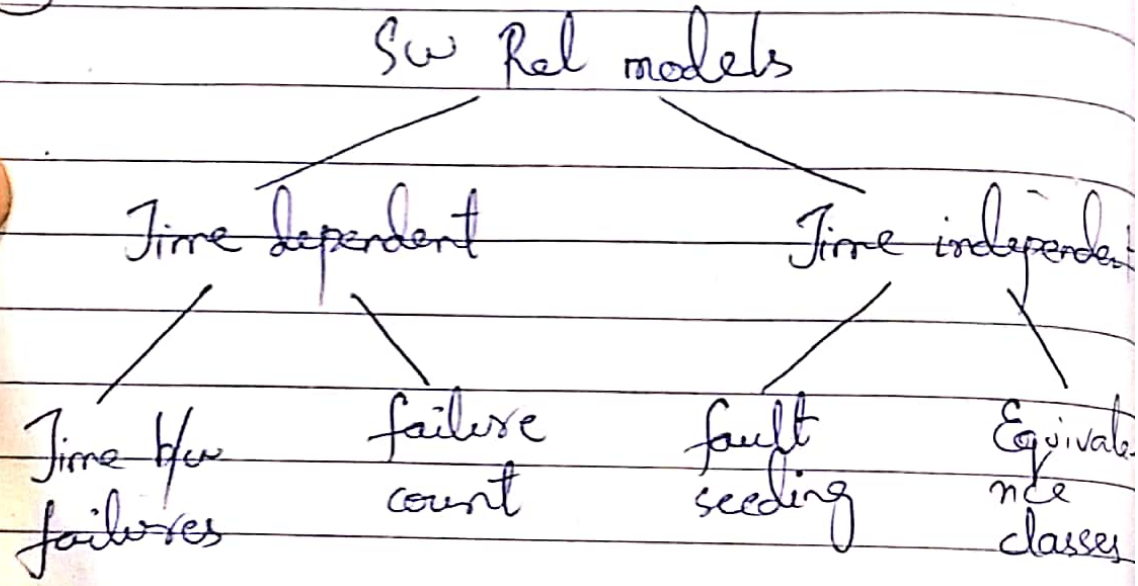
$$= \frac{(0.04)^2}{0.0512(0.0512-0.04)}$$

$$L_q = 2.790$$

(b)

① Not all code in a program is executed.
② Errors are transient
③ The system may have fault detection and protection mechanism.

(c)



(d)

For subsystem A

$$R_{ps} = R_1 \times R_2$$
$$= 0.95 \times 0.96$$
$$R_{ps} = 0.912$$

$$R_{2s} = 1 - \{(1 - 0.912)(1 - 0.94)\}$$
$$R_{2s} = 0.994$$

For subsystem B

2-out-of-3

r n

$$R_{3S} = \sum_{K=2}^{3} {}^{3}C_K (0.98)^K (1-0.98)^{3-K}$$

$$R_{3S} = {}^{3}C_2 (0.98)^2 (1-0.98) + {}^{3}C_3 (0.98)^3$$

$$R_{3S} = 0.9989$$

$$R_S = R_{2S} \times R_{3S}$$

$$R_S(t) = 0.994 \times 0.9989$$

$$R_S(t) = 0.9929$$

Question #5

(a)

$$R = 1 - \frac{3}{40} \times 0.3 - \frac{4}{50} \times 0.35 - \frac{2}{50} \times 0.35$$

$$R = 0.9355 \text{ or } 93.55\%.$$

(b) Trace means time ordered records of events on real systems.
Purpose → generally used for analysing resource management algos.
eg Paging algos, CPU sched algos, DL prevention algos.

(c) Not included in our syllabus

(d) $\frac{1}{\lambda} = 3 \text{ msec}$

$\lambda = \frac{1}{3 \text{msec}}$

$\lambda = 333.33 \text{ sec}$

$R_1 = 0.1765, R_2 = 0.4097, R_3 = 0.9132$

$t_1 = \frac{\ln(1-R_1)}{-\lambda} = 583 \text{ msec}$

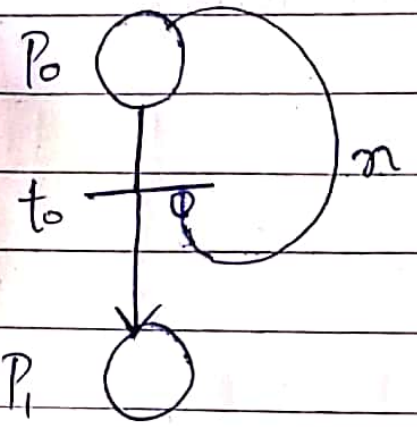
$t_2 = \frac{\ln(1-R_2)}{-\lambda} = 1582 \text{ msec}$

$t_3 = \frac{\ln(1-R_3)}{-\lambda} = 7339 \text{ msec}$

Question no: 06

(a) (i) synchronization
(ii) tokens
(iii) deadlocked
(iv) place
(v) zero
(vi) non-atomic firing (not included in syll)

(b)



(c) (1) P_3 models no of free buffers while P_2 models no of filled buffers.
(2) Transition t_2 defines filling of one buffer position & can fire only if there is one token in P_3 and P_1
(3) Transition t_3 fires if atleast one buffer is filled & in P_2 and firing of t_3 moves token from P_2 to P_3

(d)

M = Initial marking

M = (1, 0, 0)

M' = M + ($t_1 \rightarrow t_2 \rightarrow t_3 \rightarrow t_4 \rightarrow t_1 \rightarrow t_2 \rightarrow t_3$) D

D^- =	P_1	P_2	P_3
t_1	1	0	0
t_2	1	0	1
t_3	0	1	1
t_4	0	1	0

D^+ =	P_1	P_2	P_3
t_1	1	0	1
t_2	0	1	1
t_3	0	1	0
t_4	1	0	0

D =	P_1	P_2	P_3
t_1	0	0	1
t_2	-1	1	0
t_3	0	0	-1
t_4	1	-1	0

$e_1 = 1\ 0\ 0\ 0$

$e_2 = 0\ 1\ 0\ 0$

$e_3 = 0\ 0\ 1\ 0$

$e_4 = 0\ 0\ 0\ 1$

$e_1 = 1\ 0\ 0\ 0$

$e_2 = 0\ 1\ 0\ 0$

$e_3 = 0\ 0\ 1\ 0$

$X = 2\ 2\ 2\ 1$

$M' = M \times XD$

$XD = 0 - 2 + 0 + 1 = -1$

$= 0 + 2 + 0 - 1 = 1$

$= 2 + 0 - 2 + 0 = 0$

$M = 1\ 0\ 0$

$XD = -1\ 1\ 0$

$M' = 0\ 1\ 0$