V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF MATHEMATICS
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MA 6453 - PROBABILITY AND QUEUEING THEORY
UNIT-I
RANDOM VARIABLES

PART-A

1. If X is a discrete random variable with probability distribution P(X=x) =kx, x=1,2,3,4 find P(2<X<4).

We know that $\sum p(x_i) = 1$

k+2k+3k+4k = 1

k = 1/10

P (2<X<4) = P(x=3) = 3/10

2. A random variable X has the following probability function

X = i	**: 0**	**1**	**2**	**3**	**4**	**5**
P (X = i):	**0**	**k**	**3k**	**3k**	**2k**	**k**

$$\sum_{i=1}^{n} p(x_i) = 1$$

k+3k+3k+2k+k = 1

$$10k = 1 \Rightarrow k = \frac{1}{10}$$

3. If X and Y are two independent random variables with variances 2 and 3, find the Variance of 3X+4Y.

Given: Var (X) = 2 and Var (Y) = 3

Var (3X+4Y) = 3^2 Var (X) + 4^2 Var (Y) = 9(2) + 16(3) = 18 + 48 = 66.

4. A continuous random variable X has a probability density function $f(x)=3x^2, 0\le x\le 1$. Find the value of "a" such that P(X>a) = 0.05.

Given: P(X>k) = P(X≤k) = 0.05

$$\int_0^k f(x)dx = 0.05 \Rightarrow 3\int_0^k x^2 dx = 0.05 \Rightarrow \left[x^3\right]_0^k = 0.05 \Rightarrow k^3 = 0.05 \Rightarrow k = 0.7937$$

5. A continuous random variable X can assume only any value between x=2 and x=5 and has the p.d.f f(x) = k (1+x). Find P(X<4).

$$\text{WKT} \int_{-\infty}^{\infty} f(x)dx = 1 \quad \Rightarrow \quad \int_2^5 k(1+x)dx = 1$$

$$k(x+\frac{x^2}{2})_2^5 = 1 \Rightarrow k\left(\left(5+\frac{25}{2}\right)-\left(2+\frac{4}{2}\right)\right) = 1 \Rightarrow k\left(\frac{27}{2}\right) = 1 \Rightarrow k = \frac{2}{27}$$

Now P[X<4] = P(2<X4) = $\int_2^4 k(1+x)dx$

$$\int_2^4 \frac{2}{27}(1+x)dx = \frac{2}{27}\left[x+\frac{x^2}{2}\right] = \frac{2}{27}\left(\left(4+\frac{16}{2}\right)-\left(2+\frac{4}{2}\right)\right) = \frac{2}{27}(12-4) = \frac{16}{27}$$

6. A continuous random variable X has the p.d.f f(x) given by f(x) = $Ce^{-|x|}$, $-\infty < x < \infty$.

find the value of C.

We know that $\int_{-\infty}^{\infty} f(x)dx = 1$

$$\int_{-\infty}^{0} Ce^{x}dx + \int_{0}^{\infty} Ce^{-x}dx = 1$$

$$C\,[e^{x}]_{-\infty}^{0} + C\,[-e^{-x}]_{0}^{\infty} = 1 \Rightarrow c(1+1) = 1$$

$$\therefore C = \frac{1}{2}$$

7. If a random variable has the moment generating function given by $M_X(t)=\frac{2}{2-t}$ determine the variance of X.

Given $M_X(t) = \frac{2}{2-t} = \frac{2}{2\left(1-\frac{t}{2}\right)} = \left(1-\frac{t}{2}\right)^{-1} = 1+\frac{t}{2}+\left(\frac{t}{2}\right)^{2} + ...\infty$

$$= 1+\frac{t}{1!}\left(\frac{1}{2}\right)+\frac{t^2}{2!}\left(\frac{1}{2}\right)+.....$$

The coefficient of $\frac{t}{1!}$ is $\frac{1}{2}$ that is $E(X) = \frac{1}{2}$

The coefficient of $\frac{t^2}{2!}$ is $\frac{1}{2}$ that is $E(X^2) = \frac{1}{2}$

$Var(X) = E(X^2) - [E(X)]^2 = \frac{1}{2}-\frac{1}{4} = \frac{1}{4}$

8.Find the moment generating function of the p.d.f f(x) = ½,-1<x<1

$$M_X(t) = E\left(e^{tx}\right) = \int_{-1}^{1}\frac{1}{2}e^{tx}dx = \frac{1}{2}\left[\frac{e^{tx}}{t}\right]_{-1}^{1} = \frac{1}{2t}\left[e^{t}-e^{-t}\right] = \frac{\sinh t}{t}$$

9. The mean and variance of a binomial variate X are 4 and 4/3 respectively. Find P(X≥1).

mean = 4, variance =4/3

np = 4, npq =4/3

$$\frac{npq}{np} = \frac{4}{3}\times\frac{1}{4} = \frac{1}{3}$$

$$\therefore q = \frac{1}{3}$$

p=1-q=1-1/3=2/3

$$\therefore n = 4\times\frac{3}{2} = 6$$

$$P(X \geq 1) = 1 - P(X<1) = 1 - P(X=0) = 1 - {}^{6}C_{0}\left(\frac{2}{3}\right)^{0}\left(\frac{1}{3}\right)^{6-0} = 1 - \frac{1}{3^6} = 1-\frac{1}{729} = \frac{728}{729}$$

10. Comment on the treatment:"The mean of a binomial distribution is 3 and variance is 4".

Mean = 3 and variance = 4

Therefore np = 3 and npq = 4 that implies q = 4/3>1

which is impossible since q being a probability of an event,0<q<1,butq>1.

∴ The given data cannot determine a binomial distribution.

11. Obtain the binomial distribution whose mean is 6 and variance is 4.

Mean = 6 and variance = 4

Therefore np = 6 and npq = 4

q = 2/3 $\Rightarrow$ p = 1-2/3=1/3

$\therefore$ np = 6 $\Rightarrow$ n(1/3) = 6 $\Rightarrow$ n = 18

$$p(x) = nC_x p^x q^{n-x} = 18C_x \left(\frac{1}{3}\right)^x \left(\frac{2}{3}\right)^{18-x}$$

12. For a binomial distribution with mean 6 and standard deviation $\sqrt{2}$,find the first two terms of the distribution.

Mean = np = 6

Var = $(S.D)^2 = (\sqrt{2})^2 = 2$

p=1/3 and q=2/3 and n = 18

The binomial distribution is P(X=x) = $nc_x p^x q^{n-x}$

The first term is P(X=0) $= 18c_0 \left(\frac{1}{3}\right)\left(\frac{2}{3}\right)^{18-0}$

The second term is P(X=1) $= 18c_1 \left(\frac{1}{3}\right)\left(\frac{2}{3}\right)^{18-1}$

13. Every week the average number of wrong-number phone calls received by a Certain mail order house is 7.what is the probability that they will receive two wrong calls tomorrow?

Let X be the Poisson random variable with $\lambda = \frac{7}{7} = 1$

We know that $p(X = x) = \frac{e^{-\lambda}\lambda^x}{x!} = \frac{e^{-1}(1)^x}{x!}$

$$p(X = 2) = \frac{e^{-1}(1)^2}{2!} = \frac{e^{-1}}{2} = 0.18$$

14. If 3% of the electric bulbs manufactured by a company are defective, find the Probability that in a sample of 100 bulbs exactly 5 bulbs is defective. (e^{-3}=0.0498)

Let P denote the probability that a bulb is defective = 0.03

n = 100

λ = np = 0.03(100)=3

The probability distribution is P(X=x) $= \frac{e^{-\lambda}\lambda^x}{x!}$, x = 0,1,2…….

P (exactly 5 bulbs are defective) = P (x =5) = $\frac{e^{-3}3^5}{5!} = \frac{0.0498x243}{120} = 0.1008$

15. If the probability of a target to be hit on any one shot is 0.8.what is the Probability that the target is hit on the fourth attempt?)

Given p = 0.8 : q = 1-0.8 = 0.2

P(X=r) = $p.q^{r-1}$; r = 1, 2…….

P(X=4) = $(0.8)(0.2)^3$=0.0064

16. If the probability of a target is destroyed on any one shot is 0.5, find the probability that it would be destroyed on 6th attempt.

Let X be the R.V denoting the number of attempts required for the first success.

Given p = 0.5 and also q = 1-p = 0.5

P(X=x) = $p.q^{x-1}$; x = 1, 2…….

$P(X=6) = (0.5)(0.5)^5 = 0.0156$

17. State the memory less property of Geometric distribution.

If X has a geometric distribution then for any two positive integers 'm' and 'n',
$P[X>m+n/X>m] = P[X>n]$.

18. State memory less property of exponential distribution.

If X is exponentially distributed, then $P(X > S+t \ / X > S) = P(X > t)$, for any $S,t > 0$.

19. State any four properties of normal distribution.

(i) The value of f(x) approaches as x tends to $-\infty$ and x tends to ∞ that is x-axis is an asymptote to the normal curve.
(ii) The p.d.f. is symmetric about μ.
(iii) The maximum of the p.d.f. occurs at $x = \mu$.
(iv) Mean ,Median, Mode coincide.

20. Define normal distribution and what is the area under the normal curve.

A continuous random variable X, assuming all real values in $-\infty<x<\infty$ has a normal distribution if its p.d.f. is of the form $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$, here μ and σ^2 are the parameters of this distribution.Hence it is also written as $N(\mu, \sigma^2)$.
The area under the normal curve is unity.

UNIT-I
RANDOM VARIABLES
PART-B

1. (a) A random variable X has the following probability function :

X :	0	1	2	3	4	5	6	7
P(x) :	0	k	2k	2k	3k	k^2	$2k^2$	$7k^2+k$

(i) Find the value of k
(ii) Find $P(x<6)$, $P(X\geq 6)$
(iii) If $P(X\leq c) > \frac{1}{2}$ find the minimum value of c.

(b) If the density function of a continuous R.V X is given by $f(x) = \begin{cases} ax, 0 \leq x \leq 1 \\ a, 1 \leq x \leq 2 \\ 3a - ax, 2 \leq x \leq 3 \\ 0, elsewhere \end{cases}$.

(i) Find the value of 'a'
(ii) Find the c.d.f of X and
(iii) $P(X>1.5)$

2. (a) A continuous random variable X has the probability density function
$f(x) = kx^4, -1<x<0$.Find the value of k and also $P\{X > \left(\frac{-1}{2}\right) / X < \left(\frac{-1}{4}\right)\}$

(b) A continuous random variable X has the following probability density function,
$f(x) = kx^2e^{-x}$, $x\geq 0$.Find k,mean and variance of X.

3. (a) Find the moment generating function and r^{th} moment for the distribution whose pdf is $f(x) = Ke^{-x}, 0\leq x\leq\infty$.Hence find the mean and variance.

(b) If a random variable X has the moment generating function $M_X(t) = \frac{3}{3-t}$ obtain the Standard deviations of X.

4. (a) In a large consignment of electric bulbs, 10 percent are defective. A random Sample of 20

are taken for inspection. Find the probability that (1) all are good bulbs (2) at most there are 3 defective bulbs (3) exactly there are 3 defective bulbs?

(b) Find the Moment Generating Function of binomial distribution. Hence find the mean and variance.

5. (a) It is known that the probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of Packets containing at least, exactly and at most 2 defective items in a consignment of 1000 packets using Poisson approximation.

(b) Suppost that a trainee soldier shoots a target in an independent fashion. If the probability that the target is shot on any one shot is 0.7,(i) what is the probability that the target would be hit on 10th attempt? (ii) what is the probability that it takes him less than 4 shots? (iii) what is the probability that it takes him an even number of shots?

6. (a) If the probability that an applicant for a driver's license will pass the road test on any given trial is 0.8, what is the probability that he will finally pass the test; (i) on the fourth trial (ii) in fewer than 4 trials?

(b) State and prove the Memory less property of Geometric distribution.

7. (a) Find the moment generating function of Uniform distribution .Hence find its mean and Variance.

(b) Trains arrive at a station at 15 minutes intervals starting at 4 a.m. If a passenger arrive at a Station at a time that is uniformly distributed between 9.00 and 9.30, find the probability that has to wait for the train for (i) less than 6 minutes (ii) more than 10 minutes.

8. (a) Find the moment generating function of an exponential distribution and hence find its mean and variance.

(b) State and prove memory less property of exponential distribution

9. (a) Define Gamma distribution. Find its mean and variance.

(b) In a certain city, the daily consumption of electric power in millions of kilowatt hours can be treated as a random variable having Gamma distribution with parameters $\lambda = \frac{1}{2}$ and v = 3.If the power plant of this city has a daily capacity of 12 million Kilowatt-hours, what is the probability that this power supply will be inadequate on any given day?

10.(a) Let X be a normally distributed random variable with mean = 10 and the probability P(x>12) = 0.1587.What is the probability that X will be in the interval (9,11)?

(b) Find the moment generating function of the normal distribution.

UNIT-II
TWO - DIMENSIONAL RANDOM VARIABLES
PART-A

1. If the joint probability density function of X and Y is f(x,y) = $e^{-(x+y)}$,0≤x,0≤y.Are X and Y independent.

Given f(x,y) = $e^{-(x+y)}$

$$f_x(x) = f(x) = \int_{-\infty}^{\infty} f(x,y) = e^{-x}\int_0^{\infty} e^{-y}dy = e^{-x}\left[-e^{-y}\right]_0^{\infty} = -e^{-x}[0-1] = e^{-x}$$

$$f_y(y) = f(y) = \int_{-\infty}^{\infty} f(x,y) = e^{-y}\int_0^{\infty} e^{-x}dx = e^{-y}\left[-e^{-x}\right]_0^{\infty} = -e^{-y}[0-1] = e^{-y}$$

$f(x).f(y) = e^{-x}.e^{-y} = e^{-(x+y)} = f(x,y)$

Therefore X and Y are independent.

2. The joint probability density function of the random variable (X,Y) is given by f(x,y)=Kxy $e^{-(x^2+y^2)}$ x>0, y>0. Find the value of K.

By the property of the joint pdf,

$$\iint_{x>0\,y>0} f(x,y)dxdy = 1$$

$$K\int_0^{\infty}\int_0^{\infty} xye^{-(x^2+y^2)}dxdy = 1$$

$$K\int_0^{\infty} xe^{-x^2}dx\int_0^{\infty} ye^{-y^2}dy = 1$$ put $x^2 = t$; 2xdx = dt , $y^2 = u$; 2ydy = du

$$(K/2)\int_0^{\infty} e^{-t}\ dt(1/2)\int_0^{\infty} e^{-u}\ du = 1$$

$$(k/4)[\left(-e^{-t}\right)_0^{\infty}\left(-e^{-u}\right)_0^{\infty}] = 1$$

Therefore k = 4.

3. Find K if the joint p.d.f of (X,Y) is given by f(x,y) = K(1-x)(1-y),0<x, y<1
= 0 , otherwise

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)dxdy = 1$$

$$K\int_0^1\int_0^1 (1-x)(1-y)dxdy = 1$$

$$K\int_0^1 [1-x-y+xy]dxdy = 1 \Rightarrow K\int_0^1\left[1-\frac{1}{2}-y+\frac{y}{2}\right]dy = 1 \Rightarrow K\int_0^1\left[\frac{1}{2}-\frac{y}{2}\right]dy = 1$$

$$\frac{K}{2}\left[y-\frac{y^2}{2}\right] = 1 \Rightarrow K = 4$$

4. If the joint pdf of (X,Y) is given by f(x,y) = 2 in 0≤x<y≤1,find E[X].

$$f(x) = \int_{-\infty}^{\infty} f(x,y)dy = \int_{x}^{1} 2dy = 2[y]_{x}^{1} = 2[1-x]$$

$$E[X] = \int_{-\infty}^{\infty} xf(x)dx = 2\int_{0}^{1}(x-x^2)dx = 2\left(\frac{x^2}{2}-\frac{x^3}{3}\right)_0^1 = 2\left(\frac{1}{2}-\frac{1}{3}\right) = 2\left(\frac{1}{6}\right) = \left(\frac{1}{3}\right)$$

5. Given that joint probability density function of (X,Y) as f(x,y) = 1/6,0<x<2,0<y<3, Determine the marginal density.

Marginal density of X if given by

$$f(x) = \int_0^3 f(x,y)dy = \int_0^3 \frac{1}{6}dy = \frac{3}{6} = \frac{1}{2}$$

Marginal density of Y if given by

$$f(y) = \int_0^2 f(x,y)dx = \int_0^2 \frac{1}{6}dy = \frac{2}{6} = \frac{1}{3}$$

6. The joint pdf of (X,Y) is f(x,y)= 4xy, 0<x,y<1
= 0 , otherwise Examine X and Y are independent and find E(XY).

Marginal density of X, $f(x) = \int_0^1 4xydy = 2x$

Marginal density of Y, $f(y) = \int_0^1 4xydx = 2y$

f(x). f(y) = 4xy = f(x,y)

∴ X and Y are independent.

$$E(xy) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} xyf(x,y)dxdy = \int_0^1\int_0^1 xy4xydxdy = 4\int_0^1 x^2\left[\frac{y^3}{3}\right]_0^1 dx = \frac{4}{3}\left[\frac{x^3}{3}\right]_0^1 = \left(\frac{4}{3}\right)x\left(\frac{1}{3}\right) = \frac{4}{9}$$

7. If X and Y are random variables having the joint density functio f(x,y) = (6-x-y)/8, 0<x<2; 2<y<4,find P(X+Y<3).

$$P(X+Y<3) = \int_2^3\int_0^{3-y}\frac{1}{8}(6-x-y)dxdy = \frac{1}{8}\int_2^3\left(6x-\frac{x^2}{2}-xy\right)_0^{3-y}dy$$

$$= \frac{1}{8}\int_2^3\left(18-6y-\frac{9}{2}-\frac{y^2}{2}+3y-3y+y^2\right)dy$$

$$= \frac{1}{8}\int_2^3\left(\frac{y^2}{2}-6y+\frac{27}{2}\right)dy = \frac{1}{8}\left[\frac{y^3}{6}-6\left(\frac{y^2}{2}\right)+\frac{27y}{2}\right]_2^3 = \frac{1}{8}\left[-9+\frac{32}{3}\right] = \frac{5}{24}$$

8. The joint probability density function of two random variables given by $f_{xy}(x.y)$ = x(x-y)/8, 0<x<2; -x<y<x and find $f_{y/x}(y/x)$

$f_{xy}(x,y) = \frac{1}{8}x(x-y)$

$f(y/x) = \frac{f(x,y)}{f(x)}$

$$f_x(x) = \int_{-\infty}^{\infty} f(x,y)dy = \frac{1}{8}\int_{-x}^{x}(x-xy)dy = \frac{1}{8}\left[x^2y-\frac{xy^2}{2}\right] = \frac{1}{8}\left[\left(x^3-\frac{x^2}{2}\right)-\left(-x^3-\frac{x^3}{2}\right)\right]$$

$= \frac{1}{8}(2x^3) = \frac{1}{4}\ x^3$

$f(y/x) = \frac{f(x,y)}{f(x)} = \frac{1}{8}x(x-y) / \frac{1}{4}\ x^3 = \frac{1}{2x^2}(x-y)$

9. Define covariance and correlation between the random variables X and Y.

If X and Y are two random variables,then the covariance between X and Y is

$Cov(X,Y) = E[\|X - E(X)\|\|Y - E(Y)\|]$ = E(XY)-E(X).E(Y)

If (X,Y) vary in such a way that change in one variable corresponds to the change in the other variable then the variables X and Y are correlated.

10. Prove that Cov(aX,bY)=ab.Cov(X,Y).

Cov (aX,bY)= E[(aX)(bY)]-E(ax)E(bY)

= ab E(XY)-abE(X)E(Y) = ab [E(XY)-E(X)E(Y)]

= ab Cov(X,Y).

11. Write the properties of correlation coefficient.

(i) Correlation coefficient does not exceed unity.

(ii) When r=1 the correlation is perfect and positive.

(iii) Two independent variables are uncorrelated**.**

12. Show that $Cov^2(X,Y) \le Var(X).Var(Y)$.

Let X and Y be two random variables. For any real number "a"

E ([a(X- $\overline{X}$) – (Y- $\overline{Y}$)^2]) must always be non – negative.

E([a^2(X- $\overline{X}$)^2 –2a(X- $\overline{X}$)(Y- $\overline{Y}$)+ (Y- $\overline{Y}$)^2]) ≥0

[a^2 E(X- $\overline{X}$)^2 - 2aE(X- $\overline{X}$)(Y- $\overline{Y}$)+ E(Y- $\overline{Y}$)^2]) ≥0

a^2 Var(X) -2aCov(X,Y)+Var(Y) ≥0.

This is a quadratic in 'a' and is always non-negative so the discriminant must be Non positive. Therefore $Cov^2(X,Y) \le Var(X).Var(Y)$

13. If there is no linear correlation between two random variables X and Y,then what can you say about the regression lines?

When there is no linear correlation between X and Y that is when $r_{XY} = 0$.The equations of the regression lines become $y = \overline{y}$ and $x = \overline{x}$ which are at right angles.

14. State the equations of the two regression lines.

The equations of regression of y on x is given by $y - \overline{y} = r\frac{\sigma_y}{\sigma_x}(x - \overline{x})$

The equations of regression of x on y is given by $x - \overline{x} = r\frac{\sigma_x}{\sigma_y}(y - \overline{y})$

15. The regression equations of X on Y and Y on X are respectively 5x-y = 22 and 64x-45y = 24.Find the means of X and Y.

Since $\overline{x}$ and $\overline{y}$ lies on the given two lines we get

$5\overline{x} - \overline{y} = 22$…….(1)

$64\overline{x} - 45\overline{y} = 24$……..(2)

Solving the two equations we get

$\overline{x} = 6$ and $\overline{y} = 8$

Therefore Mean of X = 6 and Mean of Y = 8.

16. The two equations of the variables X and Y are x=8 - 0.9y and y=10 - 0.4x. Find the correlation co-efficient between X and Y.

The Regression Equation of X on Y is x=8 - 0.9y ; $b_{xy} = -0.9$

The Regression Equation of X on Y is y=10 - 0.4x ; b_{yx} = -0.4

The Correlation coefficient between X and Y is given by $r = \pm\sqrt{(b_{xy}b_{yx})}$ =

17. Can Y=5+2.8 X and X=3-0.5 Y be the estimated regression equations of Y on X and X on Y respectively? Explain your answer.

Given X=3-0.5 Y and Y=5+2.8 X

i.e., b_{XY} =-0.5 and b_{YX}=2.8

$r^2 = b_{XY} \times b_{YX} = -0.5 \times 2.8 = -1.4$

$r = \sqrt{-1.4}$ which is imaginary quantity

r cannot be imaginary.

∴ The given lines are not estimated as regression equations

18. Find the acute angle between the two lines of regression.

Angle between the lines is given by $\tan\theta = \frac{1-r^2}{r}\left(\frac{\sigma x \sigma y}{\sigma_x^{\ 2} + \sigma_y^{\ 2}}\right)$

UNIT-II
TWO - DIMENSIONAL RANDOM VARIABLES
PART-B

1. (a) The joint probability density function of a two-dimensional random variable (X,Y) is

$$f(x,y) = \frac{1}{8}(6-x-y), 0 < x < 2, 2 < y < 4$$

Find (i) P[X<1∩Y<3] (ii) P(X+Y<3) (3) P[X<1/Y<3].

(b) Let X and Y be two random variables having the joint probability density function f(x,y) = K(x+2y),where x and y can assume only the integer values 0,1 and 2. Find the marginal and conditional distributions.

2. (a) If the joint distribution function of x and y is given by $F(x,y) = (1-e^{-x})(1-e^{-y})$ for x>0,y>0

= 0 otherwise

(1) Find the marginal densities of x and y.

(2) Are x and y independent

(3) Find P (1<x<3, 1<y<2).

(b) The joint p.d.f of two random variables X and Y is given by f(x,y) = 2-x-y,0≤x,y≤1

= 0 , otherwise

(a) The marginal densities of X and Y.

(b) The conditional density functions of X given Y and Y given X.

(c) Cov(X, Y).

3. (a) The joint p.d.f of two random variables X and Y is given

by $f(x,y) = \begin{cases} \frac{6}{7}\left(x^2 + \frac{xy}{2}\right), 0 \le x \le 1, 0 \le y \le 2 \\ 0 \qquad , otherwise \end{cases}$ Find the conditional density function of X given Y and the conditional density function of Y given X.

(b) The joint density function of the random variables X and Y is given by

f(x,y)= 8xy,0<x<1,0<y<x

= 0, elsewhere.

(i) Find the marginal and conditional density functions.

(ii) Are x and y independent?

4. (a) Let X and Y be continuous random variables with joint p.d.f.

$$f(x,y)=\begin{cases}\frac{1}{3}x^3 e^{-(1+y)x} & ,x>0\ ,\ y>0\\ 0 & ,otherwise\end{cases}$$. Find cov(X,Y).

(b) Find the coefficient of correlation between X and Y from the following data

X :	25	28	35	32	31	36	29	38	34	32
Y :	43	46	49	42	36	32	31	30	33	38

5. (a) Calculate the coefficient of correlation from the following data:

X:	9	8	7	6	5	4	3	2	1
Y:	15	16	14	13	11	12	10	8	9

(b) The marks obtained by 10 students in Mathematics and Statistics are given below. Find the correlation coefficient between the two subjects.

Marks in mathematics:	75	30	60	80	53	35	15	40	38	48
Marks in statistics :	85	45	54	91	58	63	35	43	45	44

6. (a) Let X and Y be random variables having joint density function

$$f(x,y)=\begin{cases}\frac{3}{2}\left(x^2+y^2\right) & ,0\le x\le 1\ ,0\le y\le 1\\ 0 & ,otherwise\end{cases}$$ .Find the correlation coefficient, r_{xy} .

(b) The joint p.d.f.of two continuous random variables X and Y is given as

$$f(x,y)=\begin{cases}x+y & ,0\le x\le 1\ ,0\le y\le 1\\ 0 & ,otherwise\end{cases}$$ .Compute the correlation coefficient ρ_{xy} of the random variables X and Y.

7. (a) The regression equation of X and Y is 3y-5x+108 = 0.If the mean value of Y is 44 and the Variance of X were 9/16 th of the variance of Y.Find the mean value of X and the correlation Coefficient.

(b) If the independent random variables X and Y have the variances 36 and 16 respectively, find the correlation coefficient, r_{UV} where U =X+Y and V = X-Y.

8. (a) Find the correlation coefficient and the two lines of regression from the following data:

X:	55	56	58	59	60	60	62
Y:	35	38	37	39	44	43	44

(b) Obtain the equations of the lines of regression from the following data:

X:	1	2	3	4	5	6	7
Y:	9	8	10	12	11	13	14

9.(a) If X and Y each follow an exponential distribution with parameter 1 and are independent, find the p.d.f of U = X – Y.

(b) If X and Y are independent random variables with joint p.d.f $f(x,y)=3e^{-(x+3y)}$,$x\ge 0,y\ge 0$, Find the p.d.f of $Z=\frac{X}{Y}$.

10.(a) The joint p.d.f of X and Y is given by f(x,y) = $e^{-(x+y)}$ x>0,y>0,find the probability density function of U = (X+Y)/2.

(b) The joint p.d.f. of a two dimensional random variable (X,Y) is given by f(x,y)=x+y, $0\le x,y\le 1$, find the p.d.f. of U=XY.

UNIT – III
RANDOM PROCESSES
PART – A

1. What are the 4 types of random processes?

(i) Continuous random process
(ii) Discrete random process
(iii) Continuous random sequence
(iv)Discrete random sequence

2. What do you understand by stationary process?

If certain probability distribution or averages do not depend on t, then the random Process {X(t)} is called stationary process.

3. Define wide – sense stationary process.

A random process X(t) is called a WSS process if its mean is a constant and the autocorrelation depends only on the time difference.

4. Prove that first order stationary random process has a constant mean.

$$E[X(t+\varepsilon)] = \int_{-\infty}^{\infty} x f(x, t+\varepsilon)\,dx = \int_{-\infty}^{\infty} x f(x,t)\,dx = E[X(t)] = \text{constant.}$$

5. Define a Markov process and a Markov chain.

Markov process: If the future behavior of a process depends on the present value but not on the Past, then the process is called a Markov process.

Markov chain: Let X(t) be a Markov process which possess Markov property and which takes only discrete values whether t is discrete or continuous .Then X(t) is called as Markov chain.

Mathematically, we define the Markov chain as follows.

$$P\{X_n = a_n / X_{n-1} = a_{n-1}, X_{n-2} = a_{n-2}, \ldots\ldots\ldots, X_0 = a_0\}$$

$$\Rightarrow P\{X_n = a_n / X_{n-1} = a_{n-1}\} \text{ for all n}$$

then the process X_n; n = 0,1,2,…… are called as Markov chain.

Here $a_1, a_2, \ldots\ldots\ldots, a_n$ are called the states of the Markov chain

6. A gambler has Rs.2.He bets Re.1 at a time and wins Re.1 with probability ½.He stops playing if he loses Rs.2 or wins Rs.4.What is the transition probability matrix of the related Markov chain?)

The tpm of the Markov chain is

$$P = \begin{bmatrix} - & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 0 & 0 & 0 & 0 & 0 & - \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

The initial state probability distribution of $\{X_n\}$ is

State :	0	1	2	3	4	5	6
$P^{(0)}$ = (0	0	1	0	0	0	0)	
$P^{(1)} = P^{(0)} P$ =(0	$\frac{1}{2}$	0	$\frac{1}{2}$	0	0	0)	

$$P^{(2)} = P^{(1)} P = (\frac{1}{4} \quad 0 \quad \frac{1}{2} \quad 0 \quad \frac{1}{4} \quad 0 \quad 0)$$

$$P^{(3)} = P^{(2)} P = (\frac{1}{4} \quad \frac{1}{4} \quad 0 \quad \frac{3}{8} \quad 0 \quad \frac{1}{8} \quad 0)$$

$$P^{(4)} = P^{(3)} P = (\frac{3}{8} \quad 0 \quad \frac{5}{16} \quad 0 \quad \frac{1}{4} \quad 0 \quad \frac{1}{16})$$

$$P^{(5)} = P^{(4)} P = (\frac{3}{8} \quad \frac{5}{32} \quad 0 \quad \frac{9}{32} \quad 0 \quad \frac{1}{8} \quad \frac{1}{16})$$

$$P^{(6)} = P^{(5)} P = (\frac{29}{64} \quad 0 \quad \frac{7}{32} \quad 0 \quad \frac{13}{64} \quad 0 \quad \frac{1}{8})$$

$$P^{(7)} = P^{(6)} P = (\frac{29}{64} \quad \frac{7}{64} \quad 0 \quad \frac{27}{128} \quad 0 \quad \frac{13}{128} \quad \frac{1}{8})$$

7. Define irreducible Markov chain.

If $P_{ij}^{(n)}>0$ for some n and for every i and j ,then every state can be reached from every other state.when this condition is satisfied,the Markov chain is said to be <u>irreducible</u>.

8. Prove that the matrix $\begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ \frac{1}{2} & \frac{1}{2} & 0 \end{pmatrix}$ **is the tpm of an irreducible Markov chain.**

$$\text{Given } P = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ \frac{1}{2} & \frac{1}{2} & 0 \end{pmatrix}$$

$$P^2 = P.P = \begin{pmatrix} 0 & 0 & 1 \\ \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & \frac{1}{2} & \frac{1}{2} \end{pmatrix} \quad , \quad P^3 = P^2.P = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$$

$P_{ij}^{(n)}>0$, for all i and j,for some n.

$\therefore$The matrix of the tpm is irreducible.

9. When is a Markov chain called homogeneous?

If the one-step transition probability does not depend on the step, that is if $p_{ij}(n-1,n) = p_{ij}(m-1,m)$,then the markov chain is called the homogeneous Markov chain or the chain is said to have stationary transition probabilities.

10. Define Transition probability matrix.

When the Markov chain is homogeneous , the one step transition probability is denoted by P_{ij}. The matrix $P = (p_{ij})$ is called transition probability matrix satisfying the conditions (i) $p_{ij} \geq 0$ and (ii) $\sum p_{ij} = 1$ for all i i.e., the sum of the elements of any row of the t.p.m is 1.

11. Define one-step Transition probability.

The conditional probability $P\{X_n = a_j \mid X_{n-1}=a_i\}$ is called the one-step transition Probability from state a_i to state a_j at the nth step and is denoted by $P_{ij}(n-1,n)$.

12. What is a stochastic matrix? When is it said to be regular?

The tpm of a chain is a stochastic matrix, since all $P_{ij} \geq 0$ and the sum of all elements of any row of the transition matrix are equal to 1.

A stochastic matrix P is said to be regular matrix,if all the entries of P^m are positive.

13. If the transition probability matrix of a Markov chain is $\begin{bmatrix} 0 & 1 \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$, find the Limiting distribution of the chain.

If $\pi = (\pi_1 \quad \pi_2)$ is the steady state distribution of the chain, then by the property of π,we have,

$\pi p = \pi$ where $\pi = (\pi_1 \ . \ \pi_2)$ and $(\pi_1 + \pi_2) = 1$

$$(\pi_1 \ . \ \pi_2) \begin{bmatrix} 0 & 1 \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix} = (\pi_1 \quad \pi_2)$$

$$(\frac{1}{2}\pi_2 \quad \pi_1 + \frac{1}{2}\pi_2) = (\pi_1 \quad \pi_2)$$

$$\frac{1}{2}\pi_2 = \pi_1 \quad \Rightarrow \quad 2\pi_1 - \pi_2 = 0$$

Similarly, $\pi_1 + \frac{1}{2}\pi_2 = \pi_2$

The above equations are identical. So consider any one of the equation with

$\pi_1 + \pi_2 = 1$

$$\pi_1 = \frac{1}{3} \quad \text{and} \quad \pi_2 = \frac{2}{3}.$$

14. State Chapman-kolmogorov theorem.

If P is the transition probability matrix of a Homogeneous Markov chain ,then the n-step tpm $p^{(n)}$ is equal to P^n. i.e., $[P_{ij}^{(n)}] = [P_{ij}]^n$

15. Show that Poisson process is not a stationary.

The mean and variance of the Poisson process are $E[X(t)] = \lambda t$ and $Var[X(t)] = \lambda t$, both are functions of t. Therefore, Poisson process is not stationary process.

i.e., Poisson process is evolutionary.

16. The additive property holds good for any number of independent Poisson Process. Justify.

Let $X(t) = X_1(t) + X_2(t)$

$$P[X(t) = n] = \sum_{r=0}^{n} [P[x_1(t) = r]][P[x_2(t) = n-r]]$$

$$= \sum_{r=0}^{n} \frac{e^{-\lambda_{1}1t}(\lambda_1 t)^r e^{-\lambda_2 t}(\lambda_2 t)^{n-r}}{r!(n-r)!}$$

$$= \frac{e^{-(\lambda_1+\lambda_2)t}}{n!} \sum_{r=0}^{n} nc_r (\lambda_1 t)^r (\lambda_2 t)^{n-r} = \frac{e^{-(\lambda_1+\lambda_2)t}}{n!}(\lambda_1 t + \lambda_2 t)^n$$

$$= \frac{e^{-(\lambda_1+\lambda_2)t}}{n!}((\lambda_1 + \lambda_2)t)^n$$

$X(t) = X_1(t) + X_2(t)$ is a Poisson distribution with parameter $\lambda_1 + \lambda_2$.

17. A radioactive source emits particles at a rate of 5 per minute in accordance with Poisson process, Each particles emitted has a probability 0.6 of being recorded. Find the probability that 10 particles are recorded in 4-minperiod.

By the property of Poisson process, the number of recorded particles N(t) is a Poisson process with parameter λP.

Here λ = 5; P = 0.6 ; t = 4

$$P(N(t))=r) = \frac{e^{-\lambda pt}(\lambda pt)^r}{r!}$$

$$P(N(4)=10) = \frac{e^{-5(0.6)4}(5(0.6)4)^{10}}{10!} = \frac{e^{-12}12^{10}}{10!} = 0.1048$$

18. Prove that Poisson process is a Markov process.

Let us consider $P[X(t_3)=n_3 / X(t_2)=n_2; X(t_1)=n_1]$

$$= \frac{P[X(t_3)=n_3 / X(t_2)=n_2; X(t_1)=n_1]}{P[X(t_2)=n_2; X(t_1)=n_1]}$$

$$= \frac{e^{-\lambda t_3}\lambda^{n_2} t_1^{n_2}(t_2-t_1)^{n_2-n_1}(t_3-t_2)^{n_3-n_2}}{(n_1)!(n_2-n_1)!(n_3-n_2)!} \cdot \frac{(n_1)!(n_2-n_1)!}{e^{-\lambda t_2}\lambda^{n_2} t_1^{n_2}(t_2-t_1)^{n_2-n_1}}$$

$$= \frac{e^{-\lambda(t_3-t_2)}\lambda^{n_3-n_2}(t_3-t_2)^{n_3-n_2}}{(n_3-n_2)!}$$

$$= P[X(t_3)=n_3 / X(t_2)=n_2]$$

This means that the conditional distribution of $X(t_3)$ given all the past values $X(t_1) = n_1$, $X(t_2) = n_2$ depends only on the most recent value $X(t_2) = n_2$ .That is the Poisson process possesses the Markov process**.**

19. State any two properties of Poisson process

(i) The Poisson process possesses the Markov property.

(ii) Sum of two independent Poisson processes is a Poisson process.

(iii) Difference of two independent Poisson processes is not a Poisson process.

20. State the probability law of Poisson process.

Let λ be the rate of convergences or number of occurrences per unit time and $P_n(t)$ be the Probability of n occurrences of the event in the interval (0.t) is a Poisson distribution with Parameter λt.

i.e., $P[X(t)=n] = P_n(t) = \frac{e^{-\lambda t}(\lambda t)^n}{n!}, n = 0,1,2,.....$

UNIT – III
RANDOM PROCESSES
PART – B

1. (a) Define random process. Classify the random process with one example for each

(b) The process{X(t)} whose probability distribution under certain conditions is given by

$$P\{X(t)=n\} = \frac{(at)^{n-1}}{(1+at)^{n+1}}, n = 1,2,.....$$

$$= \frac{at}{1+at}, n = 0.$$ Show that it is not stationary

2**.** (a) Show that the random process X(t) = A cos(ωt+θ) is wide sense stationary if A & ω are constant and θ is uniformly distributed random variable in (0.2π).

(b) Show that the process X(t) = Acosλt+Bsinλt where A & B are random variables is WSS, if (i) E(A)=E(B)=0,(ii) $E(A^2)=E(B^2)$ and (iii) E(AB) =0.

3. (a) Show that the process X(t) = Acosλt+Bsinλt is WSS if A and B are independent random Variables with zero means and same variance σ^2

(b) Show that the random process $X(t) = A\sin(\omega t+\theta)$ where A and ω are constants and θ is a uniformly distributed in $(0,2\pi)$ is wide sense stationary.

4. (a) If $X(t) = Y\cos t+Z\sin t$, where Y & Z are independent random variables, each of which assumes the values -1&2 with probabilities 2/3 and 1/3 respectively. Prove that $\{X(t)\}$ is a WSS process

(b) Find the nature of the states of the Markov chain with the tpm $P=\begin{pmatrix} 0 & 1 & 0 \\ \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 1 & 0 \end{pmatrix}$

5. (a) The transition probability matrix of the Markov chain $\{X_n\}$, n = 1, 2, 3, having 3 states 1, 2 and 3 is $P = \begin{pmatrix} 0.1 & 0.5 & 0.4 \\ 0.6 & 0.2 & 0.2 \\ 0.3 & 0.4 & 0.3 \end{pmatrix}$ and the initial distribution is $P^{(0)} =(0.7, 0.2, 0.1)$.Find

(i) $P(X_2=3)$ and

(ii) $P(X_3=2,X_2=3,X_1=3,X_0=2)$.

(b) The tpm of a Markov chain with 3 states 0,1,2 is $P = \begin{pmatrix} \frac{3}{4} & \frac{1}{4} & 0 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ 0 & \frac{3}{4} & \frac{1}{4} \end{pmatrix}$ and the initial State distribution of the chain is $P(X_0=i) = \frac{1}{3}$, i = 0,1,2. Find

(i) $P(X_2=2)$ and

(ii) $P(X_3=1;X_2=2;X_1=1;X_0=2)$

6. (a) Consider a Markov chain with transition probability matrix $P=\begin{pmatrix} 0.5 & 0.4 & 0.1 \\ 0.3 & 0.4 & 0.3 \\ 0.2 & 0.3 & 0.5 \end{pmatrix}$ Find the steady state probabilities

(b) Three boys A,B and C are throwing a ball to each other. A always throws the ball to B and B always throws the ball to C, but C is just as likely to throw the ball to B as to A. Find the transition probability distribution matrix of the markov chain and also the steady-state probability distribution of the chain. Show also that the chain is irreducible.

7. (a) A salesman territory consists of three cities A,B and C. He never sells in the same City on successive days. If he sells in city-A, then the next day he sells in city-B.However if he sells in either city-B or city-A, the next day he is twice as likely to Sell in city-A as in the other city. In the long run how often does he sell in each of the cities?

(b) A house wife buys 3 kinds of cereals A,B and C, She never buys the same cereals in successive weeks. If she buys cereals A, the next week she buys B. However, jf she buys B Or C. the next week she is three times as likely to buy A as the other cereal. In the long run, how often does she buy each of the three cereals?

8. (a) Derive Chapman Kolmogorov equation.

(b) If $\{N_1(t)\}$ and $\{N_2(t)\}$ are two independent Poisson process with parameters λ_1 and λ_2 respectively, show that $P[N_1(t) =k /\{ N_1(t) + N_2(t) = n\}] = \binom{n}{k} p^k q^{n-k}$,

Where $p = \frac{\lambda_1}{\lambda_1+\lambda_2}$ and $q = \frac{\lambda_2}{\lambda_1+\lambda_2}$.

9. (a) Define Poisson process. Prove that the sum of two independent Poisson processes is also Poisson process.
   (b) Prove that the difference of two independent Poisson processes is not a Poisson process and also prove that Poisson process is a Markov process
10. (a) If customers arrive at a counter in accordance with a Poisson process with a mean rate of 2 per minute, find the probability that the interval between 2 consecutive arrivals are (i) more than 1 min (ii) between min.1 and min.2 and (iii) 4 min.or less.
   (b) Suppose that customers arrive at a bank according to a Poisson process with a mean rate of 3 per minute; find the probability that during a time interval of 2 min (i) exactly 4 customers arrive and (ii) more than 4 customers arrive.
11. (a) A machine goes out of order, whenever a component fails. The failure rate of this part follows with a mean rate of 1 per week. Find the probability that 2 weeks have elapsed since last failure. Jf there are 5 spare parts of this component in an inventory and that the next supply is not due in 10 weeks, find the probability that the machine will not be out of order in the next 10 weeks.
   (b) Derive the Probability law of Poisson process.

UNIT-IV
QUEUEING MODELS
PART-A

1. What are the basic characteristics of a queueing system?

(i). The arrival pattern

The number of arrivals per unit of time has a poisson distribution with mean λ. The time between consecutive arrivals has an exponential distribution with mean $1/\lambda$.

(ii). The service pattern

The number of customers serviced per unit of time has a Poisson distribution with mean μ or equivalently the inter-service time has an exponential distribution with Mean $1/\mu$.

(iii). The queue discipline

(i) FCFS(First Come First Served) (or) FIFO(First In First Out)
(ii) LCFS(Last Come First Served)(or)LIFO(Last In First Out)
(iii) SIRO(Service In Random Order)

2. Define Kendall's notation.

A Queuing model is represented symbolically in the form

$$(a / b / c):(d / e)$$

Where $a \rightarrow$ The type of distribution of the number of arrivals per unit time
$b \rightarrow$ The type of distribution of the service time
$c \rightarrow$ The number of servers
$d \rightarrow$ The capacity of the system (or) the maximum queue size
$e \rightarrow$ The queue discipline

3. Write down the formula for probability of n customers in the system in birth and death queuing model.

$$P_n = \frac{\lambda_0 \lambda_1 \lambda_2 \ldots\ldots \lambda_{n-1}}{\mu_1 \mu_2 \mu_3 \ldots\ldots\ldots \mu_n} P_0$$

4. Define birth and death process.

If $X(t) = n (n>0)$

(i) $P[1 \text{ birth in } (t, t+\Delta t)] = \lambda_n(t)\ \Delta t + O(\Delta t)$
(ii) $P[0 \text{ birth in } (t, t+\Delta t)] = 1 - \lambda_n(t)\ \Delta t + O(\Delta t)$
(iii) $P[2 \text{ or more births in } (t, t+\Delta t)] = O(\Delta t)$

(iv) Births occurring in (t, t+Δt) are independent of time since last birth.
(v) P[1 death in (t, t+Δt)] = $\mu_n(t)\ \Delta t+O(\Delta t)$
(vi) P[0 death in (t, t+Δt)] =1- $\mu_n(t)\ \Delta t+O(\Delta t)$
(vii) P[2 or more deaths in (t, t+Δt)] = O(Δt)
(viii) Deaths occurring in (t, t+Δt) are independent of time since last birth
(ix) The birth and death occur independently of each other at any time.
The above postulates are called Birth and Death Poisson postulates.

5. A super market has a single cashier .During peak hours, customers arrive at a rate of 20 per hour. The average number of customers that can be serviced by the cashier is 24 per hour. Calculate the probability that the cashier is idle.

Given λ = 20 per hour**.** And μ = 20 per hour

$$\rho = \frac{\lambda}{\mu} = \frac{20}{24}$$

$$P_0 = 1-\rho = 1-\frac{20}{24} = \frac{4}{24}$$

The probability that the cashier is idle = P_0 = 4/24.

6. In the usual notation of an M/M/1 queuing system, if λ=3/hour and μ=4/hour, find P(X≥5) where X is the number of customers in the system.

$$P(X\geq 5) = \left(\frac{\lambda}{\mu}\right)^{K+1} = \left(\frac{3}{4}\right)^6 = (0.75)^6 = 0.17798 = 0.1780$$

7. In the usual notation of an M/M/1 queueing system, if λ=12/hour and μ=24/hour, find the average number of customers in the system.

The average number of customers in the system = L_s = E(N) = $\frac{\lambda}{\mu-\lambda} = \frac{12}{24-12} = 1$

8. Derive the average number of customers in the system for (M/M/1):(∞/FIFO) model.

The average number of customers in the system

$$L_s = E(N) = \sum_{n=0}^{\infty} n\times P_n = \sum_{n=0}^{\infty} n\times\left(\frac{\lambda}{\mu}\right)^n\left(1-\frac{\lambda}{\mu}\right)$$

$$= \left(1-\frac{\lambda}{\mu}\right)\left[0+\frac{\lambda}{\mu}+2\left(\frac{\lambda}{\mu}\right)^2+3\left(\frac{\lambda}{\mu}\right)^3+\cdots\cdots\cdots\right]$$

$$= \frac{\lambda}{\mu}\left(1-\frac{\lambda}{\mu}\right)\left[1+2\left(\frac{\lambda}{\mu}\right)+3\left(\frac{\lambda}{\mu}\right)^2+\cdots\cdots\cdots\right]$$

$$= \frac{\lambda}{\mu}\left(1-\frac{\lambda}{\mu}\right)\left(1-\frac{\lambda}{\mu}\right)^{-2} = \frac{\lambda}{\mu}\left(\frac{\mu-\lambda}{\mu}\right)\frac{\mu^2}{(\mu-\lambda)^2} = \frac{\lambda}{\mu-\lambda}$$

9. State Little's formula for an (M/M/1):(∞/FIFO) queueing model.

(i) $E(N_s) = \lambda\ E(W_s)$
(ii) $E(N_q) = \lambda\ E(W_q)$
(iii) $E(W_s) = E(W_q) + \frac{1}{\mu}$
(iv) $E(N_s) = E(N_q) + \frac{\lambda}{\mu}$

10. What is the probability that a customer has to wait more than 15 minutes to get his

service completed in a (M/M/1):(∞/FIFO) queue system, if λ=6 per hour and μ=10 per hour?

$$P(W_s>t) = e^{-(\mu-\lambda)t}$$

$$P(W_s>\frac{15}{60}) = e^{-(10-6)\frac{1}{4}} = e^{-1} = 0.3679.$$

11. Consider an M/M/1 queuing system. If λ=6 and μ=8, find the probability of at least 10 customers in the system.

$$P(N\geq k) = \left(\frac{\lambda}{\mu}\right)^{K+1}$$

$$P(N\geq 10) = \left(\frac{6}{8}\right)^{11} = (0.75)^{11} = 0.0422.$$

12. Suppose that customers arrive at a Poisson rate of 1 per every 12 mins and that the Service time is exponential at a rate of 1 service per 8 mins.(a) What is the average number of customers in the system? (b) What is the average time of a customer spends in the system?

Given: λ = 1/12 per minute and μ = 1/8 per minute

ρ = λ/ μ = 2/3

(a) The average number of customers in the system = $\frac{\rho}{1-\rho} = 2$

(b) The average time of a customer spends in the system = $\frac{1}{\lambda}L_s = 24 \text{ min}s$

13. Define M/M/2 queuing model. why the notation M is used?

In the various queuing model, if the number of servers are 2,then it is called M/M/2 queuing model. The notation M is used to specify the Markovian or Memory less property of the exponential distribution

14. What do you mean by transient state and steady state queuing system?

Steady state : Independent of time

Transient state : Depends on time

15. What is the effective arrival rate for (M/M/1):(N/FCFS) queuing model .

The effective arrival rate is λ' = $\mu(1-P_0)$

16. What is the formula for average waiting time of a customer in the system of the queuing model(M/M/c):(∞/FIFO)

We know that by Little's formula,

$$W_S=\frac{1}{\lambda}L_S$$

$$W_S = \frac{1}{\mu s!s}\left(\frac{\lambda}{\mu}\right)^s \frac{1}{\left(1-\frac{\lambda}{\mu s}\right)^2}P_0 + \frac{\lambda}{\mu}$$

17. If there are two servers in an infinite capacity Poisson queue system with λ=10 per hour and μ=15 per hour,what is the percentage of idle time for each server?

λ=10 , μ=15 and s=2

P(Server is idle) = $1-\frac{\lambda}{s\mu} = 1-\frac{10}{2*15} = 1-\frac{1}{3} = \frac{2}{3}$

Therefore the percentage of idle time = 66.67%

18. If people arrive to purchase cinema tickets at the average rate of 6 per minute, it takes

an average of 7.5 seconds to purchase a ticket. If a person arrives 2 mins before the picture starts and it takes exactly 1.5 min to reach the correct seat after purchasing the ticket. Can he expect to be seated for the start of the picture?

Given : $\lambda = 6$ per min ,$\mu = 8$ per min

$$W_s = \frac{1}{\mu - \lambda} = \frac{1}{8-6} = \frac{1}{2}\text{min}$$

E[total time required to purchase the ticket and to reach the seat] = $\frac{1}{2} + \frac{3}{2} = \frac{4}{2} = 2\,\text{min}$

19. Arrival rate of telephone calls at a telephone booth is according to Poisson distribution with an average time of 9 minutes between two consecutive arrivals. The length of a telephone call is assumed to be exponentially distributed with mean 3 minutes. Find the probability that a person arriving at the booth will have to wait.

This problem is (M/M/1) : (∞/FIFO) Model.

Mean Arrival time = 9 mins

Mean Arrival rate (λ) = 1/9 per min.

Mean Service time = 3 mins

Mean Servicel rate (μ) = 1/3 per min

$$\rho = \frac{\lambda}{\mu} = \frac{1}{3}$$

Probability that a person will have to wait = $\frac{\lambda}{\mu} = \frac{1}{3} = 0.33$

20. Define Balking and Reneging.

Balking: A customer who leaves the queue because the queue is too long and he has no time to wait or has no sufficient waiting space.

Reneging: This occurs when a waiting customer leaves the queue due to impatience.

UNIT-IV
QUEUEING MODELS
PART-B

1. (a) Derive the balance equation of birth and death process.
   (b) Customers arrive at the first class ticket counter of a theatre at a rate of 12 per hour. There is one clerk servicing the customers at the rate of 30 per hour.
   (a) What is the probability that there is no customer at the counter?
   (b) What is the probability that there are more than 2 customers at the counter?
   (c) Find the average number of customers in the system and in the queue.
   (d) What are the average time customers spend in the queue?
2. (a) Customers arrive at a one-man barber shop according to a Poisson process with a mean Interarrival time of 12 min. Customers spend an average of 10min in the barber's chair.
   (a) What is the expected number of customers in the barber shop and in the queue?
   (b) How much time can a customer expect to spend in the barber's shop?
   (c) What is the average time customer spends in the queue?
   (d) What is the probability that more than 3 customers are in the system?
   (b) A T.V. repairman finds that the time spent on his jobs follows exponential distribution with a mean of 30 minutes. If he repairs the sets in the order of their arrival according to Poisson distribution at an average rate of 10 per 8 hour-days, find his expected idle time on each day and also the total number of sets in his shop.
3. (a) A road transport company has one reservation clerk .Customers arrive at the rate of 8per hour and the clerk can service 12 customers on an average per hour. Both arrival and service times follow Poisson process.

(i) what is the expected number of customers in the system and in the queue?
(ii) what is the average time a customer spends in the queue and in the system?

(b) The local one person barber shop can accommodate a maximum of 5 people at time (4waiting and 1 getting hair-cut) Customers arrive according to a Poisson distribution with mean 5 per hour. The barber cuts hair at an average rate of 4 per hour.
(a) What percentage of time is the barber idle?
(b) What fraction of the potential customers are turned away?
(c) What is the expected number of customers waiting for a hair-cut?
(d) How much time can a customer expect to spend in the barber shop?

4. (a) Patients arrive at clinic according to Poisson distribution at a rate of 30 patients per hour. The waiting room does not accommodate more than 14 patients. Examination time per patient is exponential with mean rate of 20 per hour.
(a) Find the effective arrival rate at the clinic.
(b) What is the probability that an arriving patient will not wait?
(c) What is the expected waiting time until a patients is discharged from the Clinic?

(b) Trains arrive at the yard every 15 minutes and the service time is 33 minutes. If the line Capacity of the yard is limited to 5 trains, find the probability that the yard is empty and the average number of trains in the system ,given that the inter arrival time and service time are following exponential distribution.

5. (a) Consider a single server queuing system with Poisson input, exponential service times. Suppose the mean arrival rate is 3 calling units per hour, the expected service time is 0.25 hours and the maximum calling units in the system is 2.Find the number of calling units in the system and the expected number of calling units in the system?

(b) There are three typists in an office. Each typist can type an average of 6 letters per hour. If letters arrive for being typed at the rate of 15 letters per hour.
(a) what fraction of the time all the typists will be busy?
(b) What is the average number of letters waiting to be typed?
(c) What is the average time a letter has to spend for waiting and for being typed?
(d) What is the probability that a letter will take longer than 20 min. waiting to be typed and being typed?

6. (a) A petrol pump station has 4 pumps. The service times follow the exponential distribution with a mean of 6 min and cars arrive for service in a Poisson process at the rate of 30 cars per hour.
(a) What is the probability that an arrival would have to wait in line?
(b) Find the average waiting time, average time spend in the system and the average number of cars in the system.
(c) For what percentage of time would a pump be idle on an average?

(b) A supermarket has 2 girls attending to sales at the counters. If the service times for each customer is exponential with mean 4min and if people arrive in Poisson fashion at the rate of 10per hour,
(a) What is the probability that a customer has to wait for service?
(b) What is the expected percentage of idle time for each girl?
(c) If the customer has to wait in the queue, what is the expected length of his Waiting time?

7. (a) A bank has two tellers working on savings account. Service time for each customer is 3 minutes and customers arrive at an average rate of 30 per hour. Assuming Poisson arrivals and exponential services, find the probability for a customer has to wait for service and also the expected waiting time.

(b) A tax consulting firm has three counters in its office to receive people who have Problems concerning their income and sales taxes. On the average 48 persons arrive in an 8-hour day.

Each tax advisor spends 15 minutes on the average on an arrival. If the arrivals are Poisson distributed and service times are exponentially distributed, find:

(a) Average number of customers in the system

(b) Average number of customers waiting to be served.

(c) Average time a customer spends in the system

(d) Average waiting time for a customer.

8.(a) A bank has 4 tellers in the counters. The service times follow the exponential distribution with a mean of 6 minutes per customer and customer arrive for service in a Poisson process at the rate of 30 per hour.

(a) What is the probability that an arrival would have to wait in line?

(b) Find the average waiting time , average time spent in the system and the average number of customers in the system.

(c) For what percentage of time would a teller remains idle?

(b) A telephone exchange has 2 long distance operators. It is observed that during the peak load long distance calls arrive in a Poisson fashion at an average rate of 15 per hour. The length of service on these calls is approximately exponentially distributed with mean length 5mins. Find:

(i) The probability a subscriber will have to waiy for long distance call during the peak hours of the day.

(ii) If the subscribers will wait and are serviced in turn, what is the expected waiting time?

9. (a). At a port there are 6 unloading berths and 4 unloading crews.When all the berths are full,arriving ships are diverted to an overflow facility 20 kms down the river.Tankers arriving according to a Poisson process with a mean of 1 every 2 h.It takes for an unloading crew,on the average,10h to unload a tanker,the unloading time following an exponential distribution.Find

(a) How many tankers are at the port on the average?

(b) How long does a tanker spend at the port on the average?

(c) What is the average arrival rate at the overflow facility?

(b) A 2-person barber shop has 5 chairs to accommodate waiting customers. Potential Customers, who arrive when all 5 chairs are full, leave without entering barber shop. Customers arrive at the average rate of 4 per hour and spend an average of 12 min in the barber's chair. Compute P_0,P_1,P_7,$E[N_q]$ and $E[W]$.

10. (a) A car servicing station has 2 bays where service can be offered simultaneously. Because of space limitation, only 4 cars are accepted for servicing. The arrival pattern is Poisson with 12 cars per day. The service time in both the bays is exponentially distributed with μ=8 cars per day per boy. Find the average number of cars in the service station, the average number of cars waiting for service and the average time a car spends in the system.

(b) Derive the governing equations for the (M/M/1);(GD/N/∞) queueing model and hence Obtain the expression for the steady state probabilities and the average number of Customers in the system.

UNIT-V
ADVANCED QUEUEING MODELS
PART-A

1. What you mean by M/G/1 queue?

In this model M → The number of arrivals in time t follows a Poisson process

G → The service time follows a general distribution

1 → Number of server is single

2. When M/G/1 queueing model will become a classic M/M/1 queueing model.

In the M/G/1 model,G stands for the general service time distribution. If the general service time distribution is replaced by exponential service time distribution then the M/G/1 model becomes the classical M/M/1 model.

3. M/G/1 queuing system is Markovian. Commend on this statement

In queuing systems , number of customers follows an exponential distributions and hence it is a Markov process where as in M/G/1 queuing system when more general service times are allotted number of customers is not a Markov process and hence M/G/1 queuing system is a non Markovian

4. Write Pollaczek-Khintchine formula and explain the notations.

$$L_s = E(N) = \lambda E(T) + \frac{\lambda^2\{V(T)+E^2(T)\}}{2\{1-\lambda E(T)\}}$$

Where T = The random service time

E(T) = Mean of T

Var(T) = Variance of T

λ = The parameter

5. When the service is constant, give the reduced form of P-K formula?

$$L_s = E(N) = \lambda E(T) + \frac{\lambda^2\{V(T)+E^2(T)\}}{2\{1-\lambda E(T)\}}$$

6. Give an example for a non Markovian queuing model

Non Markovian model is (M/G/1):(∞/GD) where M indicates the number of arrivals in time t which follows a Poisson process, G indicates that the service time follows a general distribution and GD indicates general queue discipline.

7. State Pollaczek-khintchine formula for the average number in the system in an M/G/1 queueing model and hence derive the same when the service time is constant with mean 1/μ.

$$L_S = \frac{\lambda}{\mu} + \frac{\lambda^2\left[\frac{1}{\mu^2}+\frac{1}{\mu^2}\right]}{2\left[1-\frac{\lambda}{\mu}\right]} = \frac{\lambda}{\mu} + \frac{\frac{2\lambda^2}{\mu^2}}{2\left[1-\frac{\lambda}{\mu}\right]} = \frac{\frac{\lambda}{\mu}}{1-\frac{\lambda}{\mu}} = \frac{\lambda}{\mu-\lambda}$$

8. Define series queues. .

The customer receives service at a series of service facilities in a fixed sequence is called <u>series queues</u>

9. Define series queues with blocking.

Consider a two station sequential queue with single server at each of the stations S_1 and S_2 where no queue is allowed to be formed. An entering customer has to go to S_1 for service and after completing at S_1 will go to S_2 if it is empty, otherwise will wait at S_1 till S_2 becomes empty. That is the system is blocked. This is called as <u>series</u> queues with blocking.

10. Define a two stage series queues

Consider a two stage queuing system in which customers arrive from outside at a Poisson

rate λ to S_1. After being served at S_1 then they join the queue in front of S_2. After getting the service S_2, then they leave the system. Here we are assumed that there is infinite waiting at each service point. Each server serves one customer at a time and the service times S_1 and S_2 follow distributions with parameters μ_1 and μ_2 respectively.

11. Give any two examples for series queuing situations

(i) A master health check up programme in a hospital where a patient has to undergo a series of tests.

(ii) An admission process in a school where the student has to visit a series of officials

(iii) Registration process in university

12. State burke's theorem for M/M/s queuing system

For an M/M/s queuing system, the output(departure) process is also Poisson with the same rate λ as the input(arrival) process in the steady state, where $s \geq 1$.

13. Define Jackson networks

Consider a two station sequential queue with single server at each of the stations S_1 and S_2 where no queue is allowed to be formed. An entering customer has to go to S_1 for service and after completing at S_1 will go to S_2 if it is empty, otherwise will wait at S_1 till S_2 becomes empty. That is the system is blocked. This is called as <u>series</u> queues with blocking.

14. State Jackson's theorem for an open network.

$$\lambda_j = r_j + \sum_{i=1}^{k} \lambda_i P_{ij} \text{ , j = 1,2,3,.....k}$$

where P_{ij} is the probability that a departure from server i joins the queue at server j. Traffic equations are also known as <u>Flow balance equations</u>**.** This is called Jackson's theorem for an open network

15. Write classification of queueing networks.

(i) Open network

(ii) Closed network

16. Define open Jackson networks.

Networks preserving the following characteristics are called Jackson networks

1. Arrivals from outside through node 'i' follow a Poisson process with mean arrival rate "r_i"
2. Services times at each channel at node i are independent and exponentially distributed with parameter μ_i.
3. The probability that a customer who has completed service at node "i" will go to next node "j" (routing probability) is P_{ij} (independent of the state of the system) where i = 1,2,3…….k, j = 0,1,2,……k. Also , P_{i0} denotes the probability that a Customer will leave the system from the node i.

All other general cases where $\mathbf{r_i \neq 0}$ or $\mathbf{r_{i0} \neq 0}$ for any i are referred to as <u>Open</u> Jackson Networks

17. Write the traffic equations in open Jackson networks

$$\lambda_j = r_j + \sum_{i=1}^{k} \lambda_i P_{ij} \text{ , j = 1,2,3,.....k}$$

where P_{ij} is the probability that a departure from server i joins the queue at server j. Traffic equations are also known as <u>Flow balance equations</u>**.**

18. Write the flow balance equations in open Jackson networks.

$$\lambda_j = r + \sum_{i=1}^{k} \lambda_i P_{ij,} j = 1,2,.....k$$

Where P_{ij} is the probability that a departure from server I joins the queue at server j. traffic equations are also known as flow balance equations

19. What do you mean by bottleneck of a network?

In two state tandem queue if the arrival rate increases, then the facility or node with larger value of $\rho = \frac{\lambda}{\mu}$ will cause instability and so this node is called a bottleneck of a network.

UNIT-V
ADVANCED QUEUEING MODELS
PART-B

1. (a) In a machine repair station, the machine mechanic repairs four machines. Meantime between service requirements is 5 hours for each machine with Exponential distribution and mean repair time is one hour with exponential distribution. Find
   (i) Probability that the service will be idle.
   (ii) Average number of machine waiting to be repaired and being repaired.
   (iii) Expected time a machine will wait in queue to be repaired.

   (b) A repair facility shared by a large number of machines has 2 sequential stations with respective service rates of 2 per hour and 3 per hour. The cumulative failure rate of all machines is 1 per hour. Assuming that the system behavior may be approximated by the 2 stage tandem queue, find
   (1) The average repair time including the waiting time
   (2) The probability that both the service stations are idle and
   (3) The bottleneck of the repair facility.

2. (a) Derive Pollaczek-Khinchine formula for the average number of customers in the M/G/1 queuing system.

   (b) Define open Jackson network and discuss for the steady state solution

3. (a) In a car manufacturing plant, a loading crane takes exactly 10 minutes to load a car into wagon and again come back to position to load another car. If the arrival of cars is a Poisson stream at an average of 1 every 20 minutes, calculate the following
   (i) The average number of cars in the system
   (ii) The average number of cars in the queue
   (iii) The average waiting time of a car in the system
   (iv) The average waiting time of a car in the queue.

   (b) Automatic car wash facility operates with only one bay. Cars arrive according to a Poisson Process, with mean of 4 cars per hour and may wait in the facility's parking lot if the bay is busy. If the service time for all cars is constant and equal to 10 min, Determine
   (1) Mean number of customers in the system.
   (2) Mean number of customers in the queue.
   (3) Mean waiting time in the system.
   (4) Mean waiting time in the queue.

4. A car wash facility operates with only one bay. Cars arrive according to a Poisson distribution with mean a of 4 cars per hour and may wait in the facility's parking lot if the boy is busy. The parking lot is large enough to accommodate any number of cars. Find the average number of cars waiting in the parking lot, if the time for washing and cleaning a car follows
   (a) Uniform distribution between 8 and 12 minutes.
   (b) A normal distribution with mean 12 minutes and S.D 3 minutes.
   (c) A discrete distribution with values equal to 4, 8 and 15 minutes and Corresponding probabilities 0.2, 0.6 and 0.2.

5. (a) A one man barber shop takes exactly 25 minutes to complete one hair-cut. If customers arrive at the barber shop in a Poisson fashion at an average rate of 1 every 40 minutes, how long on the average a customer spends in the shop? Also find the average time a customer must wait for service.

(b) An automatic car was facility operates with only one bay. Cars arrive according to a Poisson distribution with a mean of 4 cars/hour and may wait in the facility's parking lot if the bay is busy. Find the average number of customers in the system in the service time is

(i) Constant and is equal to 10 minutes.

(ii) Uniformly distributed between 8 and 12 minutes.

6. (a) In an ophthalmic clinic there are two sections. One for assessing the power approximately and the other for final assessment and prescription of glasses. Patients arrive at the clinic in a Poisson fashion at the rate of 3/hour. The assistant in the first section takes nearly 15 minutes per patient for approximate assessment of power and the doctor in the second section takes nearly 6 minutes per patient for final prescription. If the service times in the two sections are approximately exponential, find the probability that there are 3 patients in the first sections and 2 patients in the second sections. Find also the average number of patients in the clinic and the average waiting time of a patient in the clinic. Assume that enough spaces available for the patient in the to wait in front of both the sections and the system behavior is 2 stage series queue.

(b) In the bookshop there are two sections, one for text books and the other for note books. Customers from outside arrive at the text book sections at a Poisson rate of 4 per hour and at the note book section at a Poisson rate of 3 per hour. The service rate of the text book section and note book section are respectively 8 and 10 per hour. A customer upon completion of service at a text book section is section equally likely to go to the note book section or to leave the book shop, where as a customer upon completion of service at note book section will go to the text book section with probability 1/3 and will leave the book shop otherwise find the steady state probability that there are 4 customers in the text book section and 2 customers in the note book section. Find also the average number of customers in the book shop.

7. (a) Consider a system of two servers where customers from outside the system arrive at server 1 at a Poisson rate 4 and at server 2 at a Poisson rate 5. The service rates 1 and 2 are respectively 8 and 10. A customer upon completion of service at server 1 is equally likely to go to server 2 or to leave the system(that is $P_{11}=0, P_{12}=1/2$): where as a departure from server 2 will go 25% of the time to server 1 and will depart the system otherwise (that is $P_{21}=1/4, P_{22}=0$). Determine the limiting probabilities, Ls and Ws .

(b) A TVS company in MADURAI containing a repair section shared by a large number of machines has 2 sequential stations with respective service rates of 3 per hour and 4 per hour. The cumulative failure rate of all the machines is 1 per hour. Assuming that the system behavior can be approximated by a 2-stage tendon queue, find:

(i) The probability that both the service stations are idle

(ii) The average repair time including the waiting time

(iii) The bottleneck of the repair facility.

8. (a) There are 2 salesmen in a supermarket. Out of the 2 salesman, one is in charge of Billing and receiving payment while the other salesman is in charge of weighing and delivering the items. Due to lack of space, only if the billing clerk is free. The Customer who has finished his billing job has to wait until the delivery section becomes free. If customers arrive according to a Poisson process at rate 1 per hr and the service times of 2 clerks are independent and have exponential rates of 3 Per hr and 2 per hr. Find

(i) The proportion of customers who enter the supermarket.

(ii) The average number of customers in the supermarket.

(iii) The average amount of time a customer spends in the shop.

(b) An average of 120 students arrive each hour (inter-arrival times are exponential) at the controller office to get their hall tickets. To complete the process, a candidate must pass through three counters. Each counter consists of a single server, service times at each

counter are exponential with the following mean times: counter 1,20 Seconds: counter 2, 15 seconds and counter 3, 12 seconds .On the average how many students will be present in the controller's office.

9. (a) In a network of 3 service stations 1,2,3 customers arrive 1,2,3 from outside, in accordance with Poisson process having rates 5,10,15 respectively. The service time at the 3 stations are exponential with respective rates 10, 50, 100. A customer completing service at station 1 is equally likely to (1) go to station 2,(2) go to station 3 and (3) leave the system. A customer departing from service at station 2 always goes to station 3. A departure from service at station 3 is equally like to go to station 2 or leave the system

(i) What is the average number of customers in the system consisting of all three stations?

(ii) What is the average time a customer spend in the system?

(b) Write short notes on the following;

(i) queue networks (ii) series queue (iii) open networks

10.(a) An average of 120 students arrive each hour(inter-arrival times are exponential) at the controller office to get their hall tickets.To complete this process, a candidate must pass through three counters.Each counter consists of a single server .Service times at each counter are exponential with the following mean times:counter 1,20 seconds; counter 2, 15 seconds and counter 3,12 seconds.On the average,how many students will be present in the controller's office?

(b) Consider a open queueing network with parameter values shown below:

Facility j	s_j	μ_j	α_j	i=1	i=2	i=3
j=1	1	10	1	0	0.1	0.4
j=2	2	10	4	0.6	0	0.4
J=3	1	10	3	0.3	0.3	0

(i) Find the steady state distribution of the number of customers at facility 1, facility 2 and facility 3.

(ii) Find the expected total number of customers in the system.

(iii) Find the expected total waiting time for a customer.

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF INFORMATION TECHNOLOGY
CS6401-OPERATING SYSTEMS

PART – A

UNIT 1-OPERATING SYSTEMS OVERVIEW

1. List and briefly define the four main elements of a computer?

- Processor – Controls the operation of the computer & performs its data processing functions
- Main memory – Stores data & programs.it is volatile.
- I/O modules – Move data between the computer & its external environment such as disks, communication equipment & terminals.
- System Bus – Provides for communication among processors, main memory & I/O modules.

2. Define the two main categories of processor register?

Two categories are

- User- visible registers: - It Enable the machine or assembly language programmer to minimize main memory references by optimizing register use.
- Control & Status registers: - Registers used by the processor to control the operation of the processor.

3. In general terms, what are the four distinct actions that machine instruction can specify?

- Processor – Memory
- Processor –I/O
- Data Processing
- Control

4. What is an Interrupt?

- Interrupt are provided primarily as way to improve processor utilization.
- It is a mechanism by which other modules(I/O, Memory) may interrupt the normal sequencing of the processor

Classes of interrupts:-

- Program
- Timer
- I/O
- Hardware failure

5. How are multiple interrupt dealt with?

Two approaches can be taken to dealing with interrupts

- Disabled Interrupt – Processor ignores any new interrupt request signal.
- Define Priority for interrupt – It allows an interrupt of higher priority.

6. What characteristics distinguish the various elements of a memory hierarchy?

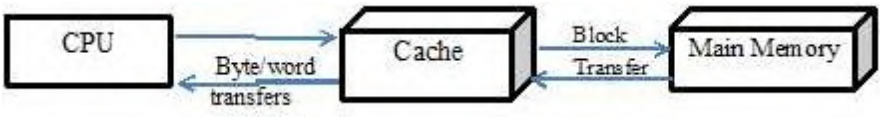
Characteristics are

1. Cost Per bit
2. Capacity

3. Access Time
4. Frequency of access to the memory by the processor
5.

7. What is Cache Memory?

1. Cache memory is invisible to the OS
2. It interacts with other memory management hardware
3. Cache contains a copy of a portion of main memory .



8. List and briefly define 3 Techniques of I/O operation?

- Programmed I/O
- Interrupt Driven I/O
- Direct memory access

9. What is the distinction b/w spatial locality & temporal locality?

Temporal locality refers to the reuse of specific data and/or resources within relatively small time durations.

Spatial locality refers to the use of data elements within relatively close storage locations. Sequential locality, a special case of spatial locality, occurs when data elements are arranged and accessed linearly, e.g., traversing the elements in a one-dimensional array.

10. Define Locality of Reference

Locality of reference, also known as the principle of locality, is the phenomenon of the same value or related storage locations being frequently accessed.

There are two basic types of reference locality.

- Temporal locality refers to the reuse of specific data and/or resources within relatively small time durations.
- Spatial locality refers to the use of data elements within relatively close storage locations.

Sequential locality, a special case of spatial locality, occurs when data elements are arranged and accessed linearly, e.g., traversing the elements in a one-dimensional array.

11. What is an operating system? (NOV/DEC 2013)

An operating system is a program that manages the computer hardware. it act as a

intermediate between a user's of a computer and the computer hardware. It controls and coordinates the use of t h e hardware among the various application programs for the various users.

12. What are the 3 objective of an OS Design?

- Convenience – An OS makes a computer more convenient to use
- Efficiency -- An OS allows the system resources to be used in efficient manner
- Ability to Evolve – An OS Constructed in such a way as to permit the effective development, testing & introducing new function.

13. List the Services of operating system function. (NOV/DEC 2013)

1. Program development
2. Program execution
3. User Interface

4. I/O Operations
5. File system Manipulation
6. Communication
7. Error Detection
8. Resource allocation
9. Accounting and Security

14. Define Kernel

The kernel is a software code that resides in the central core of a operating system. It has complete control over the system.

15. Define system call. (MAY/JUNE 2009, APRIL/MAY 2011)

System Call provides the interface between running program and the OS
User can request any services from OS through System Call.

List the categories of system call:-

- File management
- Process Management
- Inter process Communication
- I/O Device Management
- Information Processing & Maintenance

16. What is System Programs? (APRIL/MAY 2011)

System programs provide an convenient environment to the user for developing and executing the programs.

Categories:-

1. File management
2. Status Information
3. File Modification
4. Programming language support
5. Program loading & execution
6. Communication

17. What is Boot strapping?

The boot program is stored on disk with predetermined address called boot sector. The boot program then loads the operating system into memory to startup the computer this arrangement is known as bootstrapping.

18 . Difference b/w Monolithic & Microlithic.

Monolithic	**Micro lithic**
Kernel size is large	Kernel size is small
OS is Complex to design	OS is easy to Design Implement & Install
Request may be serviced faster	Request may be serviced slower
All OS services are included in the Kernel	Kernel Provides only IPC and low level Device management services

19. What is Multiprogramming? (MAY/JUNE 2013)

Multi Programming increases CPU Utilization by organizing jobs so that the CPU always has

one to execute.

Advantage:-

It increase CPU utilization
It makes efficient use of the CPU overlapping the demands for the CPU & I/O devices
Increased throughput.
Lower response time.

20. Define Real Time System

Real time system is one that must react to input & responds to them quickly. A real time system has well defined, fixed time constants.

21. What does the CPU do when there are no user programs to run? (NOV/DEC 2011)

The CPU will always do processing. Even though there are no application programs running, the operating system is still running and the CPU will still have to process.

22. Describe the actions taken by a kernel to context-switch between processes. (NOV/DEC 2013)

In general, the operating system must save the state of the currently running process and restore the state of the process scheduled to be run next. Saving the state of a process typically includes the values of all the CPU registers in addition to memory allocation. Context switches must also perform many architecture-specific operations, including flushing data and instruction caches.

23. What is multicore processor?

Hardware has been to place multiple processor cores on the same physical chip, resulting in a Multicore processor. Each core maintains its architectural state and thus appears to the operating system to be a separate physical processor.

24. What is memory stall?

Researchers have discovered that when a processor accesses memory, it spends a significant amount of time waiting for the data to become available. This situation, known as a memory stall , may occur for various reasons, such as a cache miss.

25. What is Boot strapping?

- The boot program is stored on disk with predetermined address called boot sector.
- The boot program then loads the operating system into memory to startup the computer. this arrangement is known as bootstrapping.

26. Can multiple user level threads achieve better performance on a multiprocessor system than a single processor system? Justify your answer. (MAY/JUNE 2014)

We assume that user-level threads are not known to the kernel. In that case, the answer is because the scheduling is done at the process level. On the other hand, some OS allows user-level threads to be assigned to different kernel-level processes for the purposes of scheduling. In this case the multithreaded solution could be faster

27. Mention the circumstances that would a user be better off using a time-sharing system rather than a PC or a single user workstation? (MAY/JUNE 2014)

A user is better off fewer than three situations: when it is cheaper, faster, or easier.
For example:
1. When the user is paying for management costs and the costs are cheaper for a time-sharing system than for a single-user computer.
2. When running a simulation or calculation that takes too long to run on a single PC or workstation.

3. When a user is travelling and doesn't have laptop to carry around, they can connect remotely to a time-shared system and do their work.

28. Do timesharing differ from Multiprogramming? If so, How? (APR/MAY 2015)

Time Sharing: here, OS assigns some time slots to each job. Here, each job is executed according to the allotted time slots.

Job1: 0 to 5 Job2: 5 to 10 Job3: 10 to 15

Multi-Tasking: in this operating system, jobs are executed in parallel by the operating system. But, we can achieve this multi-tasking through multiple processors (or) multicore CPU only.

CPU1: Job1 CPU2: Job2 CPU3: Job3

29. Why API s need to be used rather than system calls? (APR/MAY 2015)

System calls are much slower than APIs (library calls) since for each system call, a context switch has to occur to load the OS (which then serves the system call).

Most details of OS interface hidden from programmer by API Managed by run-time support library (Set of functions built into libraries included with compiler.)

30. Describe the actions taken by a thread library to context switch between user-level threads.

The user-level threads are known only within a given process. To context switch, we only need to save the thread-specific context: the program counter, CPU registers, and the thread-specific stack pointer.

31. What is the purpose of system programs? (May/Jun 2016)

System programs can be thought of as bundles of useful system calls. They provide basic functionality to users so that users do not need to write their own programs to solve common problems.

32. What are the advantages of peer-to-peer systems over client-server systems? (May/Jun 2016)

- It is easy to install and so is the configuration of computers on this network, all the resources and contents are shared by all the peers, unlike server-client architecture where Server shares all the contents and resources.
- P2P is more reliable as central dependency is eliminated. Failure of one peer doesn't affect the functioning of other peers. In case of Client –Server network, if server goes down whole network gets affected.
- There is no need for full-time System Administrator. Every user is the administrator of his machine. User can control their shared resources.
- The over-all cost of building and maintaining this type of network is comparatively very less.

33. Compare and contrast DMA and cache memory. (Nov/Dec 2015)

- DMA is a hardware device that can move to/from memory without using CPU instructions.
- For instance, a hardware device (lets say, your PCI sound device) wants audio to play back. You can either:
- Write a word at a time via a CPU mov instructions.
- Configure the DMA device. You give it a start address, a destination, and the number of bytes to copy. The transfer now occurs while the CPU does something else instead of spoon feeding the audio device.
- DMA can be very complex (scatter gather, etc), and varies by bus type and system.

34. Write the difference between Batch systems and Time sharing systems. (Nov/Dec 2015)

- A batch is a sequence of jobs. This batch is submitted to batch processing operating systems, and output would appear some later time in the form of a program or as program error. To speed up processing similar jobs are batched together.
- The major task of batch operating systems is to transfer control automatically from one job to next. Here the operating is always in the memory.
- Time sharing or multi-tasking is a logical execution of multiprogramming. Multiple jobs are executed by the CPU switching between them. Here the computer system provides on line communication between the user and the system.
- Here the CPU is never idle. Time shared operating system allows many users to share the computer simultaneously.
- Time sharing systems requires some sort of memory management and protection.

PART-B

UNIT – I OPERATING SYSTES OVERVIEW

1. Explain Operating System Structure and components. **[R] (APRIL/MAY 2010, NOV/DEC 2013)**

2. Discuss multiprocessor systems in detail. **[U] (MAY/JUNE 2013)**

3. Explain in detail the types of system calls provided by a typical operating system. **[R] (NOV/DEC 2012)**

4. Explain the purpose of system calls and discuss the calls related to device management and communications in brief. **[An] (MAY/JUNE 2014)**

5. Explain the concepts of virtual machines, their implementation and benefits in details. **[An] (MAY/JUNE 2014)**

6. What is a virtual machine? List out the advantages of virtualization. Explain the creation of a Virtual machine with a architecture diagram **[An] (NOV/DEC 2013**)

7. Write short notes on operating system services and components. **[U] (MAY/JUNE 2012)**

8. Write in detail about the real time system and multiprocessor system. **[U]**

9. Write in detail about hardware protection. **[U]**

10. Explain the various types of System calls with an example for each?**[U] (APR/MAY 2015)**

11. Discuss about the functionality of system boot with respect to operating system. [An] **(APR/MAY 2015)**

12. Discuss about the evolution of virtual machines. Also explain how virtualization could be implemented in operating systems. **[Ap] (APR/MAY 2015)**

13. Sketch the structure of Direct Memory Access in detail. **[U] (APR/MAY 2015)**

14. (i) With neat sketch discuss computer system overview
(ii) Enumerate the different operating system structure and explain with neat sketch **[U] (Nov/Dec 2015)**

15. (i) State the basic functions of OS and DMA.
(ii) Explain system calls, system programs and OS generation. **[U] (Nov/Dec 2015)**

16. (i) Distinguish between the client-server and peer-to-peer models of distributed systems.
(ii) Describe three general methods for passing parameters to the operating system with example**. [An] (MAY/JUNE 2016)**
(i) How could a system be designed to allow a choice of operating systems from which to boot? What would the bootstrap program need to do? **[Ap]**

UNIT –II PROCESS MANAGEMENT

PART-A

1. Define Process?

A Process can be thought of as a program in execution. A process will need certain resources such as CPU time, memory, files & I/O devices to accomplish its task.

2. Draw & briefly explain the process states?

New- The process is being created.
Running – Instructions are being executed
Waiting – The process is waiting for some event to occur
Ready – The process is waiting to be assigned a processor
Terminated - the process has finished execution

3. What is process control block? List out the data field associated with PCB. (APR/MAY2015)

Each process is represented in the operating system by a process control block also called a task cont rol block.(PCB) Also called a task control block.

Process state
Process number
Program counter
CPU registers
Memory limits
List of open files
CPU scheduling information
Memory management information
Accounting information
I/O status information

4. What is meant by context switching?

Switching the CPU to another process requires saving the state of the old process and loading the sav ed state for the new process. This task is known as context switch.

5. Define co- operating process and independent process.

INDEPENDENT PROCESS:

- A process is independent if it cannot affect or be affected by the other processes executing in the system.
- A process that does not share data with any other process is independent.

CO OPERATING PROCESS:

- A process is co-operating if it can affect or be affected by other processes executing in the system.
- Any process that shares data with any other process is cooperating.

6. What are the benefits of multithreaded programming?

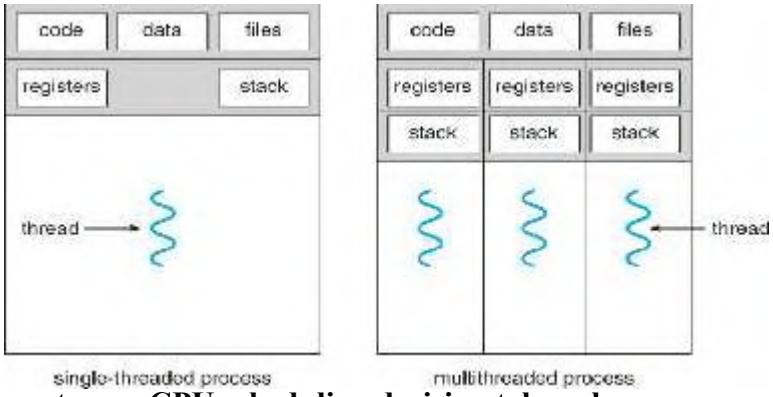
The benefits of multithreaded programming can be broken down into four major categories

- Responsiveness
- Resource sharing

- Economy scalability
- Utilization of multiprocessor architectures.

7. What is a thread?

A thread otherwise called a lightweight process (LWP) is a basic unit of CPU utilization, it comprises of a thread id, a program counter, a register set and a stack. It shares with otherthreads bel onging to the same process its code section, data section, and operating system resources such as ope n files and signals.



8. Under What circumstances CPU scheduling decision takes place.

(1) When a process switches from running state to waiting state
(2) When a process switches from running state to ready state.
(3) When a process switches from running state to waiting state to ready state
(4) When a process terminates.

9. What are the various scheduling criteria for CPU scheduling?

The various scheduling criteria are

CPU utilization
Throughput
Turnaround time
Waiting time
Response time

10. Write down the definition of TestAndSet() Instruction.

```
 boolean TestAndSet (boolean &target)
 {
  boolean rv = *target;
 *target = true;
return rv;
 }
```

11. Define busy waiting and spinlock.

Busy waiting:-

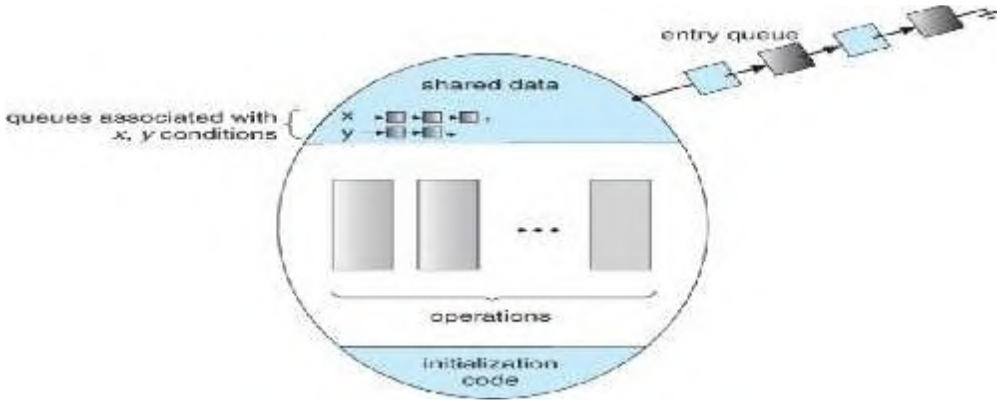
When a process is in its critical section, any other process that tries to enter its critical section Must loop continuously in the entry code. This is called as busy waiting.

Spinlock:-

Busy waiting waster CPU cycles that some other process might be able to use productively. This this type of semaphore is also called a spinlock. because the process"spin" while waiting for the lock.

12. What is mean by monitors?

A high level synchronization construct. A monitor type is an ADT which presents set of programmer define operations that are provided mutual exclusion within the monitor.



13. What are the characterizations of deadlock?

1. Mutual exclusion: only one process at a time can use a resource.
2. Hold and wait: a process holding at least one resource is waiting to acquire additional resources held by other processes.
3. No preemption: a resource can be released only voluntarily by the process holding it, after that process has completed its task.
4. Circular wait: there exists a set {$P0$, $P1$, …, $P0$} of waiting processes such that $P0$ is waiting for a resource that is held by $P1$, $P1$ is waiting for a resource that is held by $P2$, …, Pn–1 is waiting for a resource that is held by Pn, and $P0$ is waiting for a resource that is held by $P0$.Deadlock can arise if four conditions hold simultaneously.

14. Differentiate a Thread form a Process. (NOV/DEC 2012)

Threads

- Will by default share memory
- Will share file descriptors
- Will share file system context
- Will share signal handling

Processes

- Will by default not share memory
- Most file descriptors not shared
- Don't share file system context
- Don't share signal handling

15. What are the difference b/w user level threads and kernel level threads? (MAY /JUNE 2012) (MAY/ JUNE 2016) (NOV/DEC 2015)

User threads

User threads are supported above the kernel and are implemented by a thread library at the user level. Thread creation & scheduling are done in the user space, without kernel intervention. Therefore they are fast to create and manage blocking system call will cause the entire process to block

Kernel threads

Kernel threads are supported directly by the operating system .Thread creation, scheduling and management are done by the operating system. Therefore they are slower to create & manage compared to user threads. If the thread performs a blocking system call, the kernel can schedule another thread in the application for execution

16. What is the use of fork and exec system calls?

Fork is a system call by which a new process is created. Exec is also a system call, which is used after a fork byone of the two processes to place the process memory space with a new program.

17. Define thread cancellation & target thread.

The thread cancellation is the task of terminating a thread before it has completed. A thread that is to be cancelled is often referred to as the target thread. For example, if multiple threads are concurrently searching through a database and one thread returns the result, the remaining threads might be cancelled.

18. What are the different ways in which a thread can be cancelled?

Cancellation of a target thread may occur in two different scenarios:

• **Asynchronous cancellation:** One thread immediately terminates the target thread is called asynchronous cancellation.

• **Deferred cancellation:** The target thread can periodically check if it should terminate, allowing the target thread an opportunity to terminate itself in an orderly fashion.

19. Define PThreads

PThreads refers to the POSIX standard defining an API for thread creation and synchronization. This is a specification for thread behavior, not an implementation.

20. What is critical section problem?

Consider a system consists of 'n' processes. Each process has segment of code called a critical section, in which the process may be changing common variables, updating a table, writing a file. When one process is executing in its critical section, no other process can be allowed to execute in its critical section.

21. What are the requirements that a solution to the critical section problem must satisfy?

The three requirements are

- Mutual exclusion
- Progress
- Bounded waiting

22. Define mutual exclusion. (MAY/JUNE 2013)

Mutual exclusion refers to the requirement of ensuring that no two process or threads are in

their critical section at the same time.

23. i.e. If process P_i is executing in its critical section, then no other processes can be executing in Define CPU scheduling.

CPU scheduling is the process of switching the CPU among various processes. CPU scheduling is the basis of multiprogrammed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.

24. What is preemptive and nonpreemptive scheduling? (NOV/DEC 2008,APRIL/MAY 2010, MAY /JUNE 2012)

Under nonpreemptive scheduling once the CPU has been allocated to a process, the process keeps the CPU until it releases the CPU either by terminating or switching to the waiting state.

Preemptive scheduling can preempt a process which is utilizing the CPU in between its execution and give the CPU to another process.

25. What is a Dispatcher?

The dispatcher is the module that gives control of the CPU to the process selected by the short-term scheduler. This function involves:

- Switching context.
- Switching to user mode.

- Jumping to the proper location in the user program to restart that program.

26. Define the term 'dispatch latency'? (APR/MAY 2015)

The time taken by the dispatcher to stop one process and start another running is known as dispatch latency.

27. Define throughput?

Throughput in CPU scheduling is the number of processes that are completed per unit time. For long processes, this rate may be one process per hour; for short transactions, throughput might be 10 processes per second.

28. What is turnaround time? (NOV/DEC 2013)

Turnaround time is the interval from the time of submission to the time of completion of a process. It is the sum of the periods spent waiting to get into memory, waiting in the ready queue, executing on the CPU, and doing I/O.

29. Define race condition.

When several process access and manipulate same data concurrently, then the outcome of the execution depends on particular order in which the access takes place is called race condition. To avoid race condition, only one process at a time can manipulate the shared variable.

30. Write the four situations under which CPU scheduling decisions take place? (MAY/JUNE 2014)

CPU scheduling decisions take place under one of four conditions:

- When a process switches from the running state to the waiting state, such as for an I/O request or invocation of the wait ( ) system call.
- When a process switches from the running state to the ready state, for example in response to an interrupt.
- When a process switches from the waiting state to the ready state, say at completion of I/O or a return from wait ( ).
- When a process terminates.

31. Define deadlock. (APRIL/MAY 2010)

A process requests resources; if the resources are not available at that time, the process enters a wait state. Waiting processes may never again change state, because the resources they have requested are held by other waiting processes. This situation is called a deadlock.

32. What is the sequence in which resources may be utilized?

Under normal mode of operation, a process may utilize a resource in the following sequence:

- **Request:** If the request cannot be granted immediately, then the requesting process must wait until it can acquire the resource.
- **Use:** The process can operate on the resource.
- **Release:** The process releases the resource.

33. What are conditions under which a deadlock situation may arise?

A deadlock situation can arise if the following four conditions hold simultaneously in a system:

a. Mutual exclusion

b. Hold and wait

c. No pre-emption

d. Circular wait

34. What is a resource-allocation graph?

Resource allocation graph is directed graph which is used to describe deadlocks. This graph consists of a set of vertices V and a set of edges E. The set of vertices V is partitioned into two different types of nodes; P the set consisting of all active processes in the system and R the set consisting of all resource types in the system.

35. Define request edge and assignment edge.

A directed edge from process P_i to resource type R_j (denoted by $P_i \rightarrow R_j$) is called as request edge; it signifies that process P_i requested an instance of resource type R_j and is currently waiting for that resource.

A directed edge from resource type R_j to process P_i (denoted by $R_j \rightarrow P_i$) is called an assignment edge; it signifies that an instance of resource type has been allocated to a process Pi.

36. What are the methods for handling deadlocks? (APRIL/MAY 2011)

The deadlock problem can be dealt with in one of the three ways:

1. Use a protocol to prevent or avoid deadlocks, ensuring that the system will never enter a deadlock state.
2. Allow the system to enter the deadlock state, detect it and then recover.
3. Ignore the problem all together, and pretend that deadlocks never occur in the system.

37. How real-time Scheduling does differs from normal scheduling? (NOV/DEC 2012)

In a normal Scheduling, we have two types of processes. User process & kernel Process. Kernel processes have time constraints. However, user processes do not have time constraints.

In a RTOS, all process are Kernel process & hence time constraints should be strictly followed. All process/task (can be used interchangeably) are based on priority and time constraints are important for the system to run correctly.

38. What do you meant by short term scheduler (NOV/DEC 2010)

The selection process is carried out by the short term scheduler or CPU scheduler. The scheduler selects the process form the process in memory that is ready to execute and allocates the CPU to the process.

39. What is the concept behind strong semaphore and spinlock? (NOV/DEC 2015)

A spinlock is one possible implementation of a lock, namely one that is implemented by busy waiting ("spinning"). A semaphore is a generalization of a lock (or, the other way around, a lock is a special case of a semaphore). Usually, but not necessarily, spinlocks are only valid within one process whereas semaphores can be used to synchronize between different processes, too.

A semaphore has a counter and will allow itself being acquired by one or several threads, depending on what value you post to it, and (in some implementations) depending on what its maximum allowable value is

40. What is the meaning of the term busy waiting? (May/Jun 2016)

Busy waiting means that a process is waiting for a condition to be satisfied in a tight loop without relinquish the processor. Alternatively, a process could wait by relinquishing the processor, and block on a condition and wait to be awakened at some appropriate time in the future.

UNIT – II PROCESS MANAGEMENT
PART-B

1) Explain the FCFS, preemptive and non-preemptive versions of Shortest-Job First and Round Robin (time slice = 2) scheduling algorithms with Gantt charts for the four Processes given. Compare their average turnaround and waiting time. [E] **(NOV/DEC 2012)**

Process	Arrival Time	Waiting Time
P1	**0**	**8**
P2	**1**	**4**
P3	**2**	**9**
P4	**3**	**5**

2) Discuss how scheduling algorithms are selected for a system. What are the criteria considered? Explain the different evaluation Methods**.[An] (MAY/JUNE 2014)**
3) Write in detail about several CPU scheduling algorithms. **[An]** (**APRIL/MAY2011)**
4) What is critical section? Specify the requirements for a solution to critical section problem. **[An] (NOV/DEC 2012)**
5) How monitors help in process synchronization**. [An] (NOV/DEC 2009)**
6) Write in detail about deadlock avoidance**. [U] (NOV/DEC 2009)**
7) Write in detail about deadlock recovery. **[U] (APRIL/MAY2011)**
8) Explain the Banker algorithm for deadlock avoidance in detail with an example**. [Ap]** (**APRIL/MAY2010, NOV/DEC 2012) (NOV/DEC 2013)**
9) Consider the following set of processes, with the length of the CPU – burst time given in Milliseconds:

Process	Burst Time	Priority
P1	**10**	**3**
P2	**1**	**1**
P3	**2**	**3**
P4	**1**	**4**

The processes are arrived in the order P1, P2, P3, P4, all at time 0.

1. Draw 4 Gantt charts illustrating the execution of these processes using FCFS, SJF Priority and RR (Time Slice = 1) scheduling
2. What is the turnaround time of each process for each of the scheduling?
3. Calculate the waiting time for each of the process[E] **(MAY/JUNE 2012)(NOV/DEC 2015)**

10) Writers Problem with semaphores [An] **(NOV/DEC 2013)**
11) Explain the FCFS, preemptive and non-preemptive versions of Shortest-Job First and Round Robin (time slice = 2) scheduling algorithms with Gantt charts for the four Processes given. Compare their average turnaround and waiting time. [Ap] **(APR/MAY 2015)**

Process	Arrival Time	Waiting Time
P1	0	10
P2	1	6
P3	2	12
P4	3	15

12) Discuss how deadlocks could be detected in detail. [An] **(APR/MAY 2015)**
13) Show how wait() and signal() semaphore operations could be implemented in multiprocessor environments using the test and set instruction. The solution should exhibit minimal busy waiting. Develop pseudo code for implementing the operations. [An] **(APR/MAY 2015)**
14) Discuss about the issues to be considered in the multithreaded program. [An] **(APR/MAY**

2015)

15) (i) Explain thread and SMP management.

(ii) Illustrate Semaphores with neat example.

(iii) The operating system contains 3 resources, the number of instance of each resource type are 7, 7, 10. The current resource allocation state is as shown below:

Process	**Current Allocation**			**Maximum Need**		
	R_1	**R_2**	**R_3**	**R_1**	**R_2**	**R_3**
P_1	2	2	3	3	6	8
P_2	2	0	3	4	3	3
P_3	1	2	4	3	4	4

Is the current allocation in a safe state? [E] **(NOV/DEC 2015)**

16) (i) Is it possible to have concurrency but not parallelism? Explain.

(ii) Consider a system consisting of four resources of the same type that are shared by three processes, each of which needs at most two resources. Show that the system is deadlock free. [An] **(MAY/JUNE 2016)**

17.(i) Describe the actions taken by a kernel to context-switch between processes.

(iii) Provide two programming examples in which multithreading does not provide better performance than a single-threaded solution. [An] **(MAY/JUNE 2016)**

UNIT –III STORAGE MANAGEMENT

PART-A

1. Why page are sizes always powers of 2?

Recall that paging is implemented by breaking up an address into a page and offset number. It is most efficient to break the address into X page bits and Y offset bits, rather than perform arithmetic on the address to calculate the page number and offset. Because each bit 25 26 position represents a power of 2, splitting an address between bits results in a page size that is a power of 2.

2. Consider a logical address space of eight pages of 1024 words each, mapped onto a physical memory of 32 frames.

a. How many bits are there in the logical address?

b. How many bits are there in the physical address?

Each page/frame holds 1K; we will need 10 bits to uniquely address each of those 1024 addresses. Physical memory has 32 frames and we need 25 bits to address each frame, requiring in total 5+10=15 bits. A logical address space of 64 pages requires 6 bits to address each page uniquely, requiring 16bits in total.

a. Logical address: 13 bits

b. Physical address: 15 bits

3. In the IBM/370, memory protection is provided through the use of keys. A key is a 4-bit quantity. Each 2K block of memory has a key (the storage key) associated with it. The CPU also has a key (the protection key) associated with it. A store operation is allowed only if both keys are equal, or if either is zero. Which of the following memory-management schemes could be used successfully with this hardware?

a. Bare machine

b. Single-user system

c. Multiprogramming with a fixed number of processes

d. Multiprogramming with a variable number of processes

e. Paging

f. Segmentation

Answer:

a. Protection not necessary set system key to 0.

b. Set system key to 0 when in supervisor mode.

c. Region sizes must be fixed in increments of 2k bytes, allocate key with memory blocks.

d. Same as above.

e. Frame sizes must be in increments of 2k bytes, allocate key with pages.

f. Segment sizes must be in increments of 2k bytes, allocate key with segments

4. What is address binding?

The process of associating program instructions and data to physical memory addresses is called address binding, or relocation.

5. Difference between internal and external fragmentation (NOV/DEC 2013)

Internal fragmentation is the area occupied by a process but cannot be used by the process. This space is unusable by the system until the process release the space.

External fragmentation exists when total free memory is enough for the new process but it's not contiguous and can't satisfy the request. Storage is fragmented into small holes.

6. What is virtual memory? Mention its advantages. (NOV/DEC 2012)(MAY/JUNE 2014)

Virtual memory is a technique that allows the execution of processes that may not be completely in memory. It is the separation of user logical memory from physical memory. This separation provides an extremely large virtual memory, when only a smaller physical memory is available.
The main visible advantage of this scheme is that programs can be larger than physical memory.

7. Define Demand paging and write advantages.

Virtual memory is commonly implemented by demand paging. In demand paging, the pager brings only those necessary pages into memory instead of swapping in a whole process. Thus it avoids reading into memory pages that will not be used anyway, decreasing the swap time and the amount of physical memory needed.

8. What is the purpose of paging the page tables?

In certain situations the page tables could become large enough that by paging the page tables, one could simplify the memory allocation problem (by ensuring that everything is allocated as fixed-size pages as opposed to variable-sized chunks) and also enable the swapping of portions of page table that are not currently used.

9. Compare paging with segmentation with respect to the amount of memory required by the address translation structures in order to convert virtual addresses to physical addresses.

- Paging requires more memory overhead to maintain the translation structures. Segmentation requires just two registers per segment: one to maintain the base of the segment and the other to maintain the extent of the segment.
- Paging on the other hand requires one entry per page, and this entry provides the physical address in which the page is located.

10. What do you mean by thrashing? (APR/MAY 2015)

Thrashing is the coincidence of high page traffic and low CPU utilization.

11. How do you limit the effects of thrashing?

To limit the effect of thrashing we can use **local replacement algorithm**. With Local replacement algorithm, if the process starts thrashing, it cannot steal frames from another process and cause the latter to thrash as well. The problem is not entirely solved. Thus the effective access time will increase even for the process that is not thrashing.

12. What do mean by page fault?

Page fault is the situation in which the page is not available whenever a processor needs to execute it.

13. Define TLB.

- Translation ***L***ook-Aside ***B***uffer, a table in the processors memory that contains information about the pages in memory the processor has accessed recently
- The TLB enables faster computing because it allows the address processing to take place independent of the normal address-translation pipeline

14. Define lazy swapper.

Rather than swapping the entire process into main memory, a lazy swapper is used. A lazy swapper never swaps a page into memory unless that page will be needed.

15. Define effective access time.

Let p be the probability of a page fault (0£p£1). The value of p is expected to be close to 0; that is,

there will be only a few page faults. The effective access time is
Effective access time = (1-p) * ma + p* page fault time. ma: memory-access time

16. What is the basic approach of page replacement?

If no frame is free is available, find one that is not currently being used and free it. A frame can be freed by writing its contents to swap space, and changing the page table to indicate that the page is no longer in memory.
Now the freed frame can be used to hold the page for which the process faulted.

17. What is the various page replacement algorithms used for page replacement?

FIFO page replacement
Optimal page replacement
LRU page replacement
LRU approximation page replacement
Counting based page replacement
Page buffering algorithm.

18. What are the major problems to implement demand paging?

The two major problems to implement demand paging is developing
Frame allocation algorithm
Page replacement algorithm

19. What is a reference string?

An algorithm is evaluated by running it on a particular string of memory references and computing the number of page faults. The string of memory reference is called a reference string.

20. Differentiate a page from a segment. (APRIL/MAY 2010)

In segmentation, the address space is typically divided into a preset number of segments like data segment (read/write), code segment (read-only), stack (read/write) etc. And the programs are divided into these segments accordingly. Logical addresses are represented as tuple <segment, offset>. While with paging, the address space is divided into a sequence of fixed size units called "pages". And logical addresses take the form of a tuple <page, offset>.

21. What is address binding? (NOV/DEC 2010)

The process of associating program instructions and data to physical memory addresses is called address binding, or relocation.

22. How do you limit the effects of thrashing? (APRIL/MAY 2011)

To limit the effect of thrashing we can use **local replacement algorithm**. With Local replacement algorithm, if the process starts thrashing, it cannot steel frames from another process and cause the latter to thrash as well. The problem is not entirely solved. Thus the effective access time will increase even for the process that is not thrashing.

23. Mention the significance of LDT and SDT. (APR/MAY 2015)

The **Global Descriptor Table** or *GDT* is a data structure used by Intel x86-family processors starting with the 80286 in order to define the characteristics of the various memory areas used during program execution, including the base address, the size and access privileges like executability and writability. These memory areas are called *segments*.
The **Local Descriptor Table** (LDT) is a memory table used in the x86 architecture in protected mode and containing memory segment descriptors: start in linear memory, size, executability,

writability, access privilege, actual presence in memory, etc.

- The LDT is supposed to contain memory segments which are private to a specific program, while the GDT is supposed to contain global segments.
- The x86 processors contain facilities for automatically switching the current LDT on specific machine events, but no facilities for automatically switching the GDT.
- The LDT is the sibling of the Global Descriptor Table (GDT) and defines up to 8192 memory segments accessible to programs –
- Unlike the GDT, the zeroth entry is a valid entry, and can be used like any other LDT entry.
- Unlike the GDT, the LDT cannot be used to store certain system entries: TSSs or LDTs.

24. Define demand paging in memory management. What are the steps required to handle a page fault in demand paging. (Nov/Dec 2015)

A demand paging system is quite similar to a paging system with swapping where processes reside in secondary memory and pages are loaded only on demand, not in advance. When a context switch occurs, the operating system does not copy any of the old program's pages out to the disk or any of the new program's pages into the main memory Instead, it just begins executing the new program after loading the first page and fetches that program's pages as they are referenced. While executing a program, if the program references a page which is not available in the main memory because it was swapped out a little ago, the processor treats this invalid memory reference as a page fault and transfers control from the program to the operating system to demand the page back into the memory.

25. How does the system detect thrashing? (May/Jun 2016)

Thrashing is caused by under allocation of the minimum number of pages required by a process, forcing it to continuously page fault. The system can detect thrashing by evaluating the level of CPU utilization as compared to the level of multiprogramming. It can be eliminated by reducing the level of multiprogramming.

26. Name two differences between logical and physical addresses. (May/Jun 2016)

A logical address does not refer to an actual existing address; rather, it refers to an abstract address in an abstract address space. Contrast this with a physical address that refers to an actual physical address in memory. A logical address is generated by the CPU and is translated into a physical address by the memory management unit(MMU). Therefore, physical addresses are generated by the MMU.

UNIT III STORAGE MANAGEMENT
PART-B

1. Describe the hierarchical paging technique for structuring page tables. (8) **[An] (MAY/JUNE 2013)**
2. What is the cause for thrashing? How does the system detect thrashing? Once it detects, what can the system do to eliminate this problem? **[An] (MAY/JUNE 2009)**
3. Write in detail about Segmentation**.[U] (NOV/DEC 2009)**
4. Write in detail about Segmentation with Paging. **[U] (APRIL/MAY2010)**
5. Explain the segmentation with paging implemented in OS/2 32-bit IBM system. Describe the following algorithms: **[An] (APRIL/MAY2010)**

a. First fit
b. Best Fit
c. Worst Fit

6. Explain how paging supports virtual memory. With a neat diagram explain how logical address is translated into physical address. **[An] (NOV/DEC 2012)**
7. Explain the principles of segmented and paging implemented in memory with a diagram**. [U] (NOV/DEC2013)**

8. Explain the segmentation with paging implemented in MULTICS system. **[U]**
9. Explain the various page table structures in detail. **[U]** (**APRIL/MAY2011)(MAY/JUNE 2014)**
10. Write short notes on LRU, FIFO and clock replacement strategies? **[An] (APRIL/MAY2010, APRIL/MAY2011)**
11. Explain any four page replacement algorithms in detail? **[An] (NOV/DEC 2009) (NOV/DEC 2013)**
12. What is thrashing? Explain the working set model in detail. [An] **(MAY/JUNE 2009)**
13. Given memory partitions of 100KB, 500KB, 200KB, 300KB and 600KB(in order), how would each of the first-fit, best-fit and worst-fit algorithms place processes of212KB, 417KB, 12KB and 426KB(in order)? Which algorithm makes the most efficient use of memory? [Ap] **(NOV/DEC 2008)**
14. (i) Explain in briefly and compare, fixed and dynamic memory partitioning schemes.
    (ii) Explain FIFO, optimal and LRU page replacement algorithms with an example reference Strings. Mention the merits and demerits of each of the above algorithms. **[An] (NOV/DEC 2012)**
15. Consider the following page reference string **(MAY/JUNE 2012) (APR/MAY 2015)**
    1,2,3,4,2,1,5,6,2,1,3,7,6,3,2,1,3,6.

How many page faults would occur for the following replacement algorithms, assuming one, two, three and four frames?
LRU replacement
FIFO replacement
Optimal replacement [E]

16. (i) Consider the following page reference string:
    2, 1, 0, 3, 4, 0, 0, 0, 2, 4, 2, 1, 0, 3, 2.
    How many page faults would occur if the working set policy were used with a window size of 4? Show when each page fault would occur clearly. [E]
    (ii) What is meant by thrashing? Discuss in detail. [An] **(MAY/JUNE 2013)**
17. Explain the concept of demand paging in detail with neat diagram [U] **(MAY/JUNE 2014)**
18. Why are translation look-aside buffers important? Explain the details stored in a TLB table entry**?** **[An] (MAY/JUNE 2014)**
19. Consider the following page reference string :
    1,2,3,4,2,1,5,6,1,2,3,7,6,3,2,1,2,3,6.How Many page faults would occur for the LRU, FIFO, LFU and optimal page replacement algorithms, assuming two and five frames? **[E](MAY/JUNE 2014)**
20. Explain the concept of demand paging and the performance issue of short process Explain the issue of demand paging [An] **(NOV/DEC 2013)**
21. With a neat sketch, explain how logical address is translated into physical address using paging mechanism? **[An] (APR/MAY 2015)**
22. Write short notes on Memory Mapped Files. **[U] (APR/MAY 2015)**
23. (i) Consider the following page reference string:
    1,2,3,2,5,6,3,4,6,3,7,3,1,5,3,6,3,4,2,4,3,4,5,1
    Indicate page faults and calculate total number of page faults and successful ratio for FIFO, optimal and LRU algorithms. Assume there are four frames and initially all the frames are empty. [E]
    (ii) Explain the effect of thrashing. [An] **(NOV/DEC 2015)**
24. Discuss the given memory management techniques with diagrams.
    - Partition Allocation Methods
    - Paging and Translation Look-aside Buffer. [An] **(NOV/DEC 2015)**
25. (i) Describe a mechanism by which one segment could belong to the address space of two different processes.
    (ii) Why are segmentation and paging sometimes combined into one scheme? Explain them in detail with example. [An] **(MAY/JUNE 2016)**

UNIT-IV I/O SYSTEMS
PART-A

1) What is a file?

A file is a named collection of related information that is recorded on secondary storage. A file contains either programs or data. A file has certain "structure" based on its type.

2) List the various file attributes. (APRIL/MAY 2011, NOV/DEC 2012)(MAY/JUNE 2014)(APRIL/MAY 2015)

A file has certain other attributes, which vary from one operating system to another, but typically consist of these:

- Identifier
- Name
- Type
- Location
- Size
- Protection
- Time
- Date
- user identification

3) What are the various file operations? (NOV/DEC 2012, APRIL/MAY 2015)

The six basic file operations are:

- Creating a file
- Writing a file
- Reading a file
- Repositioning within a file
- Deleting a file
- Truncating a file

4) What are all the information's associated with an open file?

Several pieces of information are associated with an open file which may be:

- File pointer
- File open count
- Disk location of the file
- Access rights

5) What are the different accessing methods of a file? (APRIL/MAY 2010)

The different types of accessing a file are:

Sequential access: Information in the file is accessed sequentially

Direct access: Information in the file can be accessed without any particular order.

Other access methods: Creating index for the file, indexed sequential access method (ISAM) etc.

6) What is Directory?

The device directory or simply known as directory records information-such as name, location, size, and type for all files on that particular partition. The directory can be viewed as a symbol table that translates file names into their directory entries.

7) What are the operations that can be performed on a directory?

The operations that can be performed on a directory are

- Search for a file
- Create a file
- Delete a file
- Rename a file
- List directory
- Traverse the file system

8) What are the most common schemes for defining the logical structure of a directory? (MAY/JUNE 2012)

The most common schemes for defining the logical structure of directory

- Single-Level Directory
- Two-level Directory
- Tree-Structured Directories
- Acyclic-Graph Directories
- General Graph Directory

9) Define UFD and MFD.

In the two-level directory structure, each user has her own user file directory (UFD). Each UFD has a similar structure, but lists only the files of a single user. When a job starts the system's master file directory (MFD) is searched. The MFD is indexed by the user name or account number, and each entry points to the UFD for that user.

10) What is a path name?

A pathname is the path from the root through all subdirectories to a specified file. In a two-level directory structure a user name and a file name define a path name.

11) What are the various layers of a file system?

The file system is composed of many different levels. Each level in the design uses the feature of the lower levels to create new features for use by higher levels.

i. Application programs
ii. Logical file system
iii. File-organization module
iv. Basic file system
v. I/O control
vi. Devices

12) What are the structures used in file-system implementation? (APRIL/MAY 2011)

Several on-disk and in-memory structures are used to implement a file system

On-disk structure include

Boot control block
Partition block
Directory structure used to organize the files
File control block (FCB)

In-memory structure include

In-memory partition table
In-memory directory structure
System-wide open file table
Per-process open table

13) What are the functions of virtual file system (VFS)?

1. It separates file-system-generic operations from their implementation defining a clean VFS interface. It allows transparent access to different types of file systems mounted locally.
2. VFS is based on a file representation structure, called a vnode. It contains a numerical value for a network-wide unique file .The kernel maintains one vnode structure for each active file or directory.

14) Define seek time and latency time.

The time taken by the head to move to the appropriate cylinder or track is called seek time. Once the head is at right track, it must wait until the desired block rotates under the read-write head. This delay is latency time.

15) What are the allocation methods of a disk space?

Methods of allocating disk space which are widely in use are

- Contiguous allocation
- Linked allocation
- Indexed allocation

16) What are the advantages of Contiguous allocation?

The advantages are

- Supports direct access
- Supports sequential access
- Number of disk seeks is minimal.

17) What are the drawbacks of contiguous allocation of disk space?

The disadvantages are

- Suffers from external fragmentation.
- Suffers from internal fragmentation.
- Difficulty in finding space for a new file.
- File cannot be extended.
- Size of the file is to be declared in advance.

18) What are the disadvantages of linked allocation?

The disadvantages are

- Used only for sequential access of files.
- Direct access is not supported.
- Memory space required for the pointers.
- Reliability is compromised if the pointers are lost or damaged

19) What are the advantages of Indexed allocation?

The advantages are

- No external-fragmentation problems.
- Solves the size-declaration problems.
- Supports direct access.

20) How can the index blocks be implemented in the indexed allocation scheme?

The index block can be implemented as follows

- L
  inked scheme

- Multilevel scheme
- Combined scheme

21) What is garbage collection? (MAY /JUNE 2012)

Garbage Collection (**GC**) is a form of automatic memory management. The garbage collector, or just collector, attempts to reclaim garbage, or memory occupied by objects that are no longer in use by the program.

22) Mention the objectives of File Management System. (APR/MAY 2010)

The system that an operating system or program uses to organize and keep track of files. For example, a hierarchical file system is one that uses directories to organize files into a tree structure.

23) What is the content of a typical file control block? (APR/MAY 2011, APR/MAY 2010)

File Control Block (**FCB**) is a file system structure in which the state of an open file is maintained.

File permissions
File dates (create, access, write)
File owner, group, ACL
File size
File data blocks

24) What are the two types of system directories? (MAY/JUNE 2012)

Device directory, describing physical properties of files.
File directory, giving logical properties of the files.

25) What is meant by polling? (MAY/JUNE 2014)

Polling is the process where the computer waits for an external device to check for its readiness. The computer does not do anything else than checking the status of the device .Polling is often used with low-level hardware. Example: when a printer connected via a parallel port the computer waits until the next character has been received by the printer. These processes can be as minute as only reading 1 Byte. Polling is the continuous (or frequent) checking by a controlling device or process of other devices, processes, queues, etc.

26) State any three disadvantages of placing functionality in a device controller, rather than in the kernel. (MAY/JUNE 2014)

Three advantages:-

a. Bugs are less likely to cause an operating system crash.
b. Performance can be improved by utilizing dedicated hardware and hard-coded algorithms.
The kernel is simplified by moving algorithms out of it.

Three disadvantages:

a. Bugs are harder to fix - a new firmware version or new hardware is needed
b. Improving algorithms likewise require a hardware update rather than just kernel or device driver update
c. Embedded algorithms could conflict with application's use of the device, causing decreased performance.

27) How free-space is managed using bit vector implementation?

The free-space list is implemented as a bit map or bit vector. Each block is represented by 1 bit. If the block is free, the bit is 1; if the block is allocated, the bit is 0.

28) List the attributes of a file (MAY/JUNE 2014)

Name, Identifier, Type, Location, Size, Protection, Time, Date and User authentication.

29) What are the information contained in a boot control block and partition control block? (MAY/JUNE 2014)

Boot control block:

Contain information needed by the system to boot an operating from that partition. If the disk does not contain an operating system, this block can be empty. It is typically the first block of a partition. In UFS, this is called the boot block.

Partition Control block:

Contains partition details, such as number of blocks in the partition, size of the blocks, free block count and free block pointers, and free FCB count and FCB pointers.

30) Define buffering.

A buffer is a memory area that stores data while they are transferred between two devices or between a device and an application. Buffering is done for three reasons

a. To cope with a speed mismatch between the producer and consumer of a data stream

b. To adapt between devices that have different data transfer sizes

c. To support copy semantics for application I/O

31) Define caching.

A cache is a region of fast memory that holds copies of data. Access to the cached copy is more efficient than access to the original. Caching and buffering are distinct functions, but sometimes a region of memory can be used for both purposes.

32) Define spooling.

A spool is a buffer that holds output for a device, such as printer, that cannot accept interleaved data streams. When an application finishes printing, the spooling system queues the corresponding spool file for output to the printer. The spooling system copies the queued spool files to the printer one at a time.

33) Define rotational latency and disk bandwidth. (NOV/DEC 2010, MAY/JUNE 2013)

Rotational latency is the additional time waiting for the disk to rotate the desired sector to the disk head.

Disk bandwidth is the total number of bytes transferred, divided by the time between the first request for service and the completion of the last transfer.

34) What are the various disk-scheduling algorithms?

The various disk-scheduling algorithms are

- First Come First Served Scheduling
- Shortest Seek Time First Scheduling
- SCAN Scheduling
- C-SCAN Scheduling

35) What is the need for disk scheduling? (NOV/DEC 2012)

In operating systems, seek time is very important. Since all device requests are linked in queues, the seek time is increased causing the system to slow down.

Disk Scheduling Algorithms are used **to reduce the total seek time** of any request.

36) What is low-level formatting?

Before a disk can store data, it must be divided into sectors that the disk controller can read and write. This process is called low-level formatting or physical formatting. Low-level formatting fills the disk with a special data structure for each sector. The data structure for a sector consists of a header, a data area, and a trailer.

37) What is the use of boot block?

For a computer to start running when powered up or rebooted it needs to have an initial program to run. This bootstrap program tends to be simple. It finds the operating system on the disk loads that kernel into memory and jumps to an initial address to begin the operating system execution. The full bootstrap program is stored in a partition called the boot blocks, at fixed location on the disk. A disk that has boot partition is called boot disk or system disk.

38) What is sector sparing?

Low-level formatting also sets aside spare sectors not visible to the operating system. The controller can be told to replace each bad sector logically with one of the spare sectors. This scheme is known as sector sparing or forwarding.

39) What is seek time? (MAY /JUNE 2012)

Seek time: the time to position heads over a cylinder (~8 msec on average).

40) What are storage area networks? (April/May 2011)

A **storage area network** (**SAN**) is a dedicated network that provides access to consolidated, block level data storage. SANs are primarily used to make storage devices, such as disk arrays, tape

libraries, and optical jukeboxes, accessible to servers so that the devices appear like locally attached devices to the operating system.

41) Write a brief note on RAID. (MAY/JUNE 2013)

RAID (redundant array of independent disks; originally *redundant array of inexpensive disks*) is a way of storing the same data in different places (thus, redundantly) on multiple hard disks. By placing data on multiple disks, I/O (input/output) operations can overlap in a balanced way, improving performance. Since multiple disks increase the mean time between failures (MTBF), storing data redundantly also increases fault tolerance.

42) What Characteristics determine the disk access speed? (MAY /JUNE 2012)

- Seek time
- Rotational latency
- Command processing time
- Settle time

43) Give the importance of Swap space Management. (NOV/DEC 2012, APR/MAY2010 NOV/DEC 2010)

Swap-space management: Swap-space management is low- level task of the operating system. The main goal for the design and implementation of swap space is to provide the best throughput for the virtual memory system.

Swap-space use: The operating system needs to release sufficient main memory to bring in a process that is ready to execute. Operating system uses this swap space in various ways. Paging systems may simply store pages that have been pushed out of main memory. UNIX operating system allows the

use of multiple swap spaces. These swap space are usually put on separate disks, so the load placed on the I/O system by paging and swapping can be spread over the systems I/O devices.
Swap-space location: Swap space can reside in two places:
1. Separate disk partition
2. Normal file system

44) Write three basic functions which are provided by the hardware clocks and timers. (APRIL/MAY 2011)

- OSTickInit()
- OSTimeSet()
- OSTimeGet()

45) What are the advantages of Linked allocation?

The advantages are
No external fragmentation.
Size of the file does not need to be declared.

46) Define FAT (NOV/DEC 2014)

FAT is a much older file-system format that is understood by many systems besides Windows, such as the software running on cameras. A disadvantage is that the FAT file system does not restrict file access to authorized users. The only solution for securing data with FAT is to run an application to encrypt the data before storing it on the file system.

47) What is Relative block number? (NOV/DEC 2014)

Relative block number is an index relative to the beginning of a file. Thus the 1st relative block of the file is 0, the next is 1, and so on.

48) What is double buffering? (NOV/DEC 2014)

OS can use various kinds of buffering:
1. Single buffering — OS assigns a system buffer to the user request
2. double buffering — process consumes from one buffer while system fills the next
3. circular buffers — most useful for bursty I/O

49) What is HSM? Where it is used?

Hierarchical storage management (HSM) is a data storage technique, which automatically moves data between high-cost and low-cost storage media. HSM systems exist because high-speed storage devices, such as hard disk drive arrays, are more expensive (per byte stored) than slower devices, such as optical discs and magnetic tape drives.

50) Identify the two important functions of Virtual File System(VFS) layer in the concept of file system implementation. (Nov/Dec 2015)

Linux VFS provides a set of common functionalities for each files ystem, using function pointers accessed through a table. The same functionality is accessed through the same table position for all file system types, though the actual functions pointed to by the pointers may be files ystem-specific. Common operations provided include open( ), read( ), write( ), and mmap( ).

51) How does DMA increase system concurrency? (May/Jun 2016)

DMA increases system concurrency by allowing the CPU to perform tasks while the DMA system transfers data via the system and memory buses. Hardware design is complicated because the DMA

controller must be integrated into the system and the system must allow the DMA controller to be a bus master.

52) Why rotational latency is usually not considered in disk scheduling? (May/Jun 2016)
Most disks do not export their rotational position information to the host. Even if they did, the time for this information to reach the scheduler would be subject to imprecision and the time consumed by the scheduler is variable, so the rotational position information would become incorrect. Further, the disk requests are usually given in terms of logical block numbers, and the mapping between logical blocks and physical locations is very complex.

53) What is Relative block number? (NOV/DEC 2014)
Relative block number is an index relative to the beginning of a file. Thus the 1st relative block of the file is 0, the next is 1, and so on.

54) What is double buffering? (NOV/DEC 2014)
OS can use various kinds of buffering:
4. Single buffering — OS assigns a system buffer to the user request
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UNIT IV I/OSYSTEMS
PART-B

1) Explain the different disk scheduling algorithms with examples. [An] **(APRIL/MAY 2010, MAY/JUNE 2012, APRIL/MAY 2011, MAY/JUNE 2013) (MAY/JUNE 2014)**

2) Explain and compare FCFS, SSTF, C-SCAN and C-LOOK disk scheduling algorithms with examples. [An] **(NOV/DEC 2012)**
3) Write short notes on disk management. [U] **(NOV/DEC 2009)**
4) Write short notes on file system in Linux. [U] **(NOV/DEC 2009) (NOV/DEC 2014)**
5) Write an elaborate note on RAID and RAID Levels. [U] **(APRIL/MAY 2010, MAY/JUNE 2012, NOV/DEC 2012, MAY/JUNE 2013)**

6) Explain the services provided by Kernel I/O subsystem. **[An] (APRIL/MAY 2010, APRIL/MAY 2011, NOV/DEC2012, MAY/JUNE 2013)**
7) Consider the following I/O scenarios on a single-user PC.
- A mouse used with a graphical user interface.
- A tape drive on a multitasking operating system (assume no device preallocation is available)
- A disk drive containing user files.
- A graphics card with direct bus connection, accessible through memory-mapped I/O For each of these I/O scenarios, would you design the operating system to use buffering, Spooling, caching, or a combination? Would you use polled I/O, or interruption driven I/O? [An]

8) Write short notes on File types, File attributes, File operations [U]

9) Explain the file allocation methods. [U] **(APRIL/MAY 2010)**
10) Explain the role of Access Matrix for protection in files. [An] **(APRIL/MAY 2010)**

11) Write in detail the security measures taken in file system?
12) Write short notes on file system mounting[An]
13) Write in detail about the various file organizations [An]
14) Explain the allocation of frames in detail. [An]
15) Explain directory subsystem **[U] (APRIL/MAY 2011)**
(i) Explain Linked File Allocation method (6)
(ii) Explain the issues in designing a file system. (8)
(iii) Explain the various file directory structures. (8) **(NOV/DEC 2012)**
16) (i) Explain the different file access methods in detail. (8) **(MAY/JUNE 2014)**
(ii) Describe the two level and acyclic graph schemes for defining the logical structure of a directory. [An] **(MAY/JUNE 2013)**
17) Explain the Linked list and indexed file allocation methods with neat diagram. Mention their advantages and disadvantages. (8) [An] **(MAY/JUNE 2013)**
18) What are the most common schemes for defining the logical structure of a directory? [An] **(MAY/JUNE 2014)**
19) Write a brief note on the steps involved in DMA transfer [U] **(MAY/JUNE 2014)**

20) Explain the data structures supported by kernel I/O system [U] **(MAY/JUNE 2014)**
21) Write a brief note on tertiary storage devices [U] **(MAY/JUNE 2014)**
22) Explain different directory implementation methods [U]**(NOV/DEC 2013)**
23) Why disk scheduling is necessary? Explain the different seek optimization techniques [An] **(NOV/DEC 2013)**
24) Explain about RAID structure in disk management with various RAID levels of organization in detail [An] **(Apr/May 2015)**
25) Briefly discuss about the various directory structures**. [An] (APR/MAY 2015)**
26) Compare the functionalities of FCFS, SSTF, SCAN AND C-LOOK disk scheduling algorithms with an example for each. **[An] (APR/MAY 2015)**
27) Write short notes on free space management. [U] **(APR/MAY 2015, MAY/JUNE 2013)**
28) (i) Discuss the functions of files and file implementation.
(ii) Explain free space management with neat example. [U] **(Nov/Dec 2015)**
29) On a disk with 200 cylinders, numbered 0 to 199, compute the number of tracks the disk arm must move to satisfy the entire request in the disk queue. Assume the last request received was at truck 100. The queue in FIFO order contains requests for the following tracks. 55, 58, 39, 18, 90, 160, 150, 38, 184. Perform the computation to find the seek time for the following disk scheduling algorithms.

- FCFS
- SSTF
- SCAN
- C-SCAN
- LOOK [E] **(Nov/Dec 2015)**

30) (i) Why it is important to balance file-system I/O among the disks and controllers on a system in a multitasking environment?
(ii) Discuss the advantages and disadvantages of supporting links to files that cross mount points. [An] (**MAY/JUNE 2016)**

31) (i) Explain why logging metadata updates ensures recovery of a file system after a file-system crash.
(ii) Could a RAID level 1 organization achieve better performance for read requests than a RAID level 0 organization? If so, how? [An] (**MAY/JUNE 2016)**
32) Explain the different disk scheduling algorithms with examples. [An] **(APRIL/MAY**

2010, MAY/JUNE 2012, APRIL/MAY 2011, MAY/JUNE 2013) (MAY/JUNE 2014)

33) Explain and compare FCFS, SSTF, C-SCAN and C-LOOK disk scheduling algorithms with examples. [An] **(NOV/DEC 2012)**
34) Write short notes on disk management. [U] **(NOV/DEC 2009)**
35) Write short notes on file system in Linux. [U] **(NOV/DEC 2009) (NOV/DEC 2014)**
36) Write an elaborate note on RAID and RAID Levels. [U] **(APRIL/MAY 2010, MAY/JUNE 2012, NOV/DEC 2012, MAY/JUNE 2013)**
37) Explain the services provided by Kernel I/O subsystem. **[An] (APRIL/MAY 2010, APRIL/MAY 2011, NOV/DEC2012, MAY/JUNE 2013)**
38) Consider the following I/O scenarios on a single-user PC.

- A mouse used with a graphical user interface.
- A tape drive on a multitasking operating system (assume no device preallocation is available)
- A disk drive containing user files.
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39) Write short notes on File types, File attributes, File operations [U]

40) Explain the file allocation methods. [U] **(APRIL/MAY 2010)**
41) Explain the role of Access Matrix for protection in files. [An] **(APRIL/MAY 2010)**
42) Write in detail the security measures taken in file system? **[U]**
43) Write short notes on file system mounting[An]
44) Write in detail about the various file organizations [An]
45) Explain the allocation of frames in detail. [An]

UNIT –V CASE STUDY
PART-A

1) What is Linux distribution?

A Linux distribution includes all the standard components of the Linux system, plus a set of administrative tools to simplify the initial installation and subsequent upgrading of Linux and manage installation and removal of other packages on the system.

2) What is the use of User mode?

Under Linux, no user code is built into the kernel. Any operating-system-support code that does not need to run in kernel mode is placed into the system libraries and runs in user mode.

3) What are the components of kernel mode

The module support under Linux has four components:

1. The **module-management** system allows modules to be loaded into memory and to communicate with the rest of the kernel.
2. The **module loader and unloader,** which are user-mode utilities, work with the module-management system to load a module into memory.
3. The **driver-registration system** allows modules to tell the rest of the kernel that a new driver has become available.
4. **A conflict-resolution mechanism** allows different device drivers to reserve hardware resources and to protect those resources from accidental use by another driver.

4) What is process Identity?

Each process has a unique identifier. The PID is used to specify the process to the operating system when an application makes a system call to signal, modify, or wait for the process. Additional identifiers associate the process with a process group (typically, a tree of processes forked by a single user command and login session.

5) Define DNS

The domain name system(DNS) provides host-name-to-network-address translations for the entire Internet. Before DNS became widespread, files containing the same informationwere sent via e-mail or ftp between all networked hosts.

6) What is virtualization?

Virtualization, in computing, refers to the act of creating a virtual (rather than actual) version of something, including but not limited to a virtual computer hardware platform, operating system (OS), storage device, or computer network resources.

7) What is the responsibility of kernel in Linux operating system?

Kernel is the core part of Linux. It is responsible for all major activities of this operating system. It is consists of various modules and it interacts directly with the underlying hardware. Kernel provides the required abstraction to hide low level hardware details to system or application programs.

8) Why Virtualization is required? (Nov/Dec 2015)

Virtualization reduces the number of physical servers, reducing the energy required to power and cool them. Save time. With fewer servers, you can spend less time on the manual tasks required for server maintenance. It's also much faster to deploy a virtual machine than it is to deploy a new physical server.

9) Enumerate the requirements for Linux system administrator. Brief any one. (Nov/Dec 2015)

1. While specific knowledge is a boon, most hiring managers require that you possess basic knowledge about all aspects of Linux. For example, a little knowledge about Solaris, BSD, nginx or various flavors of Linux never hurt anyone!
2. Knowledge in at least one of the upper tier scripting language is a must. You have options before you, for instance, Python, Perl, Ruby or more, but you need to make yourself proficient in

at least one of them.

3. Experience is welcome, but you at least need to have some hands-on experience of system management, system setup and managing Linux or Solaris based servers as well as configuring them.

4. Knowledge in shell programming and architecture is valued very much in the job market. If you know Buorne or Korn well, you can even score a high-paying salary with minimal experience.

5. Storage technologies like FC, NFS or iSCSI is great, while knowledge regarding backup technologies is a must for a system administrator.

10) State the components of a Linux System? (May/Jun 2016)

- **Kernel:** The kernel is responsible for maintaining all the important abstractions of the operating system, including such things as virtual memory and processes.functions, and password-changing functions (so that, when users change their passwords, all the necessary authentication mechanisms can be updated at on **System libraries:** The system libraries define a standard set of functions through which applications can interact with the kernel. These functions implement much of the operating- system functionality that does not need the full privileges of kernel code.
- **System utilities:** The system utilities are programs that perform individual, specialized management tasks. Some system utilities are invoked just once to initialize and configure some aspect of the system.

11) Define the function of Caching-only servers. (May/Jun 2016)

All DNS servers cache answers to queries they receive from outside their own zone of authority. A cache-only DNS server is not authoritative for any zone. Related Topics: DNS root servers: Root servers are critical to the function of a DNS server that is directly connected to the Internet.

UNIT V CASE STUDY
PART-B

1. Explain in detail about the concepts of Linux system. **[U]**
2. Explain in detail about virtualization **[U]**
3. Explain in detail about setting up a Linux mainframe server **[An]**
4. Explain in detail about Linux host and adding guest OS **[U]**
5. Explain the significance and steps involved in setting up Xen, VMware software's on Linux host for successful virtualization in detail. **[An] May/June 2015**
6. Briefly discuss about the requirements to become a Linux system administrator. **[An] May/June 2015**
7. Discuss about the steps involved in the installation of a Linux Multifunction server. **[An] May/June 2015**
8. Write a short note on Linux Network Services. **[U] May/June 2015**
9. Write about LINUX architecture and LINUX kernel with neat sketch**. [U] (Nov/Dec 2015)**
10. Explain in detail about LINUX multifunction server, DNS VMware on LINUX host. **[An] (Nov/Dec 2015)**
11. (i) Why is live migration possible in virtual environments but much less possible for a native operating system?
(ii) What are the primary goals of the conflict-resolution mechanism used by the Linux kernel for loading kernel modules. **[An] (May/June 2016)**
12. Explain in step-by-step procedure for setting up a Linux multifunction server. **[An] (May/June 2016)**

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF INFORMATION TECHNOLOGY
CS-6402 DESIGN AND ANALYSIS OF ALGORITHMS

UNIT I INTODUCTION
PART-A

1. What is meant by algorithms?(Apr/May2017)

An algorithm is a sequence of unambiguous instructions for solving a problem in a finite amount of time.

2. Write a short note on Algorithm Design and Analysis of Process.

- Understand the problem
- Decide on Computational Device Exact Vs Approximate Algorithms
- Algorithm Design Techniques
- Design an algorithms
- Prove Correctness
- Analyze the Algorithm
- Code the Algorithm

3. What are the 2 kinds of Algorithm Efficiency?

a)Time Efficiency-How fast your algorithm runs?
b)Space Efficiency-How much extra memory your algorithm needs?

4. How can you specify Algorithms?

Algorithms can be specified natural language or pseudo code.

5. What is Pseudo Code?

Pseudo Code is a mixture of Natural Language and Programming Language Constructs such as functions, loops, decision making statements.etc

6. What are the Important Problem Types?

- Sorting
- Searching
- String Processing
- Graph Problem
- Combinatorial Problem
- Geometric Problem
- Numerical Problem

7. How can you Classify Algorithms

Among several ways to classify algorithms, the 2 principal alternatives are

- To group algorithms according to types of problem they solve com
- To group algorithms according to underlying design techniques they are based upon

8. What is Sorting Problem?

Sorting algorithm is rearranging the items of given list descending/ascending order. Sorting algorithms classified into

- Stable Sorting Algorithm
- Non-Stable Algorithm

9. What is Searching Problem?

Finding a given value, called search key given set. Searching Algorithms needs more memory space and sorted array.

10. What is Graph Problem?

Graph is a collection of dg s and vertices. G=(V,E). For e.g. Traversal Algorithms, Shortest Path Algorithm, Graph Colouring Problem

11. What is Combinatorial Problem?

This problem that ask to find combinatorial object such as permutations, combinations or a subset. Combinatorial problems are most difficult to solve. For eg travelling sales man problem.

12. Differentiate Time Efficiency and Space Efficiency?

Time Efficiency measured by counting the number of times the algorithms basic operation is executed. Space Efficiency is measured by counting the number of extra memory units consumed by the algorithm.

13. What are the features of efficient algorithm?

- Free of ambiguity
- Efficient in execution time
- Concise and compact Completeness
- Definiteness Finiteness

14. Define Order of Algorithm

The order of algorithm is a standard notation of an algorithm that has been developed to represent function that bound the computing time for algorithms. The order of an algorithm is a way of defining its efficiency. It is usually referred as O-notation.

15. Define Big Omega Notation.

Omega notation provides lower bound for the function t

A function t(n) is said to Omega (g(n)), if there exist some. Positive constant C and some non negative integer N0, such that

$$t(n) >= Cg(n) \text{ for all } n >= n0$$

16. What is Big 'Oh' Notation?

The Big 'Oh' notation provides an upper bound for the function t. A function t(n) is said to be O(g(n)), if there exist some positive constant C and some non negative number, suchthat, $t(n) <= Cg(n)$, for all $n >= no$

17. What are the different types of time complexity?

The time complexity can be classified into 3 types, they are

- Worst case analysis
- Average case analysis
- Best case analysis

18. How the algorithm's time efficiency is measured.

Time efficiency indicates how fast an algorithm runs. Time taken by a program to complete its task depends on the number of steps in an algorithm. The time taken by an algorithm is the sum of compile time and execution time. The compile time does not depend on the instance characteristics.

19. Enlist few algorithmic strategies.

1. Brute force 2.Divide and conquer 3.Greedy technique 4.Dynamic Programming 5.Backtracking 6.Branch and bound.

20. What is the best, worst, average case time complexities of linear search algorithm?

The O(n) is the best, worst, average case time complexities of linear search algorithm

21. Define Program proving and Program verification.

Program proving means proving each and every instruction of the program with the help of mathematical theorems. Program verification means checking the correctness of the program.

PART –B
UNIT I INTRODUCTION

1. Discuss in detail about fundamentals of algorithmic problem solving?
2. Explain the important problem types in detail
3. Explain the necessary steps for analyzing the efficiency of recursive algorithms
4. Explain the general framework for analyzing the efficiency of algorithm.
5. Write the asymptotic notations used for best case ,average case and worst case analysis of algorithms and Write an algorithm for finding maximum element of an array perform best , worst and average case complexity with appropriate order notations
6. Explain the method of solving recurrence equations with suitable example.
7. Explain the method of solving Non recursive equations with suitable examples
8. i)Describe the basic efficiency classes in detail.

   ii) Write an algorithm for Fibonacci numbers generation and compute the following

   . How many times is the basic operation executed

   . What is the efficiency class of this algorithm
9. Solve the following recurrence relations

   a) $x(n)=x(n-1) + 5$ for $n > 1$ $x(1)=0$

   b) $x(n)=3x(n-1)$ for $n > 1$ $x(1)=4$

   c) $x(n)=x(n-1)+n$ for $n > 0$ $x(0)=0$

   d) $x(n)=x(n/2)+n$ for $n > 1$ $x(1)=1$ (solve for $n=2k$)

   e) $x(n)=x(n/3)+1$ for $n >1$ $x(1)=1$ (solve for $n=3k$)
10. Consider the following recursion algorithm

```
Min1(A[0 -------n-
1]) If n=1 return
A[0]
Else temp = Min1(A[0…….n-
2]) If temp <= A[n-1] return
temp Else
Return A[n-1]
```

What does this algorithm compute?

Setup a recurrence relation for the algorithms basic operation count and solve it

UNIT-II BRUTE FORCE AND DIVIDE AND CONQUER

PART-A

1. What is Empirical Analysis?

It is performed by running a program implementing the algorithm on a sample of inputs and analyzing the data observed. This involves generating pseudo code and random numbers.

2. Define Convex-Hull Problem.

A set of points (finite or infinite) on the plane is called convex if for any two Points P and Q in the set, the entire line segment with the end points at P and Q belongs to the set.

3. What is Divide and Conquer Algorithm?

It is a general algorithm design techniques that solved problem's instance by dividing it into several smaller instance, solving of them recursively, and then combining their solutions to the original instance of the Problem.

4.What are the Features of Algorithm Visualization?

- Consistent
- Interactive
- Very Clear and Concense
- Emphasize the visual component

5. Define O-Notation.

A function t(n) is said to be O (g(n)), denoted t(n) C O (g(n)), if t(n) is bounded above by some constant multiple of g(n) for all large n, ie ., if there exist some positive constant c and some nonnegative integer 0 such that

t(n) <= cg(n) for all>=0

6. What is Algorithm Visualization?

It is defined as the use of images to convey some useful information about algorithms.

7. Define Static Algorithm Visualization?

Static Algorithm Visualization shows an algorithms progress through a series of still images. On other hand, Algorithm animation shows a continuous movie like presentation of an algorithm's operation.

8. What is Fibonacci Numbers?

The Fibonacci numbers are an important sequence of integers in which every element is equal to the sum of its two immediate predecessors. There are several algorithms for computing the Fibonacci numbers with drastically different efficiency.

9.What is the Classification of Algorithm Visualization?

Static Algorithm Visualization and Dynamic Algorithm Visualization

10.What is Brute Force?

Brute Force is a straightforward approach to solving problem, usually directly based on the problem's statement and definitions of the concepts involved.

11. What are the different criteria used to improve the effectiveness of algorithm?

- Input- Zero or more quantities are externally supplied .
- Output-At least one quantity is produced
- Definiteness-Each instruction is clear and unambiguous
- Finiteness-If we trace out the instructions of algorithm, then for all case the algorithm terminates after finite number of steps
- Effectiveness-Every instruction must be very clear

12. What is recursive call?

An algorithm is said to be recursive if the same algorithm invoked in the body. There are 2 types of algorithm. They are

1) Direct Recursive
2) Indirect Recursive

13. What is meant by direct recursive call?

An algorithm that calls itself is direct recursive call. Eg.int fun(int x)

```
{
        if(x<=0)
      return x;
   return (fun(x-1));}
```

14. Define indirect recursive call?

Algorithm A is said to be indirect recursive if it calls another algorithm which in turn call A Eg: int fun(int x)

```
{
if(x<=0)
return x;
return (f1(x-1));
}
Int   fun1(int   y){
return fun(y-1)
}
```

15. List the application areas of algorithm visualization?

The 2 application are of algorithm visualization are Research and Education.

16. Define Extrapolation?

`Extrapolation is approach, which deals with values of n that are outside of the range of the samples values.

17.Define profiling?

Profiling is an important resource the empirical analysis of an algorithm running time. Measuring n different segments of program can pinpoint a bottleneck in the program's performance that can be missed by an abstract deliberation about the algorithm's basic operations. The process of getting such data is called profiling.

18. Define travelling salesman problem.

Travelling salesman problem can be stated as follows-Consider that there are n cities and traveling salesman has to visit each city exactly once and has to return to the city from where he has started.

19. What is convex hull problem?

The convex hull H(s) the smallest convex set S. The convex set is a set of points in the plane that the smallest convex polygon in the plane that contains all of the points of S. The polygon is convex if any two points from the set forming a line segment with end points entirely within the polygon.

20. Comment on assignment problem.

Consider that there are n people who need to be assigned to execute n jobs .i.e only one person is assigned to execute one job at a time. Then problem is to find such assignment that gives smallest total cost. The cost can be computed as cost C [i, j] i.e. i^{th} person assigned to j^{th} job.

UNIT –II BRUTE FORCE AND DIVIDE AND CONQUER
PART-B

Explain selection sort and bubble sort algorithm using brute force method and analyze with examples

1. Describe Sequential search and brute force string matching using brute force method
3. Explain the following in detail
   i) Closest pair problem
   ii) Convex hull problem
4. Describe exhaustive search in detail
5. Explain in detail quick sorting method. Provide a complete analysis of quick sort with example.
6. Explain in detail merge sort. Illustrate the algorithm with a numeric example. Provide complete analysis of the same.
7. Describe binary search in detail? And provide the complete analysis with example
8. Write short notes on the following
   i. Strassen's Matrix Multiplication
   ii.Multiplication of largest integer.

UNIT III DYNAMMIC PROGRAMMING AND GREEDY TECHNIQUE
PART-A

1. What is articulation point?

A vertex of a connected graph G is said to be in articulation point, if its removal with all edges incident to it breaks the graph into disjoint pieces.

2.**List the advantages of binary search?**

- Less time is consumed
- The processing speed is fast
- The number of iterations is less. It take n/2 iterations.
- Binary search, which is used in Fibonacci Series, involves addition and subtraction rather than division
- It is priori analysis, since it can be analyzed before execution.

3. Explain the principle used quick sort?

It is a partition method using the particular key the given table is partitioned into 2 sub tables so that first, the original key will be its position the sorted sequence and secondly, all keys to the left of this key will be less value and all keys to the right of it will be greater values.

4. What is binary search?

The binary search algorithm some of the most efficient searching techniques which requires the list to be sort descending order.

To search for an amount of the list, the binary search algorithms split the list and locate the middle element of the list.

First compare middle key K1, with given key K . If K1=K then the element is found.

5. What are the objectives of sorting algorithm?

- To rearrange the items of a given list
- To search an element in the list.

6. Why is bubble sort called by the name?

The sorting problem is to compare adjacent elements of the list and exchange them if they are out of order. By doing it repeatedly, we end up bubbling up the largest element to the

last position on the list. The next pass bubbles up the second largest element and so on until, after n-1 pass the list is sorted.

7. What are the 3 variations in transform and conquer?

The principle variations of transformed and conquer techniques are

- Instance simplification
- Representation change
- Problem reduction

8. Explain principle of Optimality?

The principle of optimality says that an optimal solution to any instance of an optimization problem is composed of optimal solution to its sub instances.

9. What is need for finding minimum spanning tree?

Spanning tree has many applications. Any connected graph with n vertices much have atleast-1 edges and connected graphs with n-1 edges are trees. If the nodes of G represent cities and edges represent possible communication links connecting 2 cities, then the minimum number of links needed to connect the cities is -1. Therefore, it is necessary for finding minimum spanning tree.

10.What is spanning tree?

Let G={V,E} be an undirected connected graph. A sub graph t={V,E} of G is a spanning tree of G, if it is tree.

12. What is Dynamic programming?

Dynamic programming is an algorithm design technique for solving problem with overlapping subprograms. The smaller subprograms are solved only once and recording the results in a table from which the solution to the original problem is obtained.

13. What is greedy method?

The greedy method is the most straight forward design, which is applied for change making problem. The greedy technique suggests constructing a solution to an optimization problem through a sequence of steps, each expanding a partially constructed solution obtained so far, until a complete solution to the problem is reached. On each step, the choice made must be feasible, locally optimal and irrevocable.

14.List the advantage of greedy algorithm

1) Greedy algorithm produces a feasible solution
2) Greedy method is very simple to solve a problem
3) Greedy method provides an optimal solution directly

15. Define the term control abstraction?

Control abstraction is procedure whose flow of control is learn but whose primary operations are specified by other proceed res whose precise meanings are left undefined.

16. List the applications of minimum spanning tree?

Spanning tree are used to obtain independent set of circuit equations for an electric network. Another application of spanning tree arises from the property that a spanning tree is minimal sub graph G' of G such that

V (G')=V(G) and G'

17. Define AVL Tree.

An AVL Tree is binary search tree which the balance factor of every node, which the balance

factor of every node, which is defined as the difference between the heights of the node's left and right sub trees is either 0 or +1 or -1

18. What do you mean by row major and column major?

In given matrix, the maximum elements particular row is called row major. In a given matrix, the maximum elements in a particular column is called column major.

19. What is Minimum Cost Spanning Tree?

A minimum cost spanning tree of a weighted connected graph is its spanning tree of the smallest weight, where the weight of the tree is defined as the sum of the weights on all its edges.

20. State the applications of Huffman's tree.

Huffman encoding is used in file compression algorithm.

Huffman's code is used in transmission of data in an encoded form.

This encoding is used in game playing.

21. What is an optimal solution?

Optimal solution is the best choice selected from the set of feasible solutions. This solution can be minimum or the maximum value of the solution.

22. State the time complexity of Prim's algorithm.

The time complexity of Prim's algorithm is O (|V2|).

23. Mention the drawback of Greedy algorithm.

Greedy method is comparatively efficient than divide and conquer but there is no as such guarantee of getting optimum solution.

In Greedy method, the optimum selection is without revising previously generated solutions.

UNIT III DYNAMMIC PROGRAMMING AND GREEDY TECHNIQUE
PART-B

1. Write an algorithm for binomial coefficient computation and analyze the efficiency of algorithm
2. Describe the Warshall's algorithm with example and analyze its efficiency
3. Explain Floyd's Algorithm for all pair shortest path algorithm with example and analyze its efficiency
4. Explain optimal binary search tree algorithm with example and analyze its efficiency
5. Describe Knapsack problem and Memory functions with example
6. Apply the bottom up dynamic programming algorithm to the following instance

Item no	Weight	Value
1	7	$42
2	3	$12
3	4	$40
4	5	$25

CAPACITY WEIGHT=10

7. Explain in detail about prims algorithm with example and analyze its efficiency
8. Describe in detail about Kruskals Algorithm with example and analyze its efficiency
9. Explain Dijkstra's Algorithm in detail with example and analyze its efficiency

UNIT-IV ITERATIVE IMPROVEMENT

PART-A

1. What is iterative improvement method?

This is a computational technique in which with the help of initial feasible solution the optimal solution is obtained iteratively until no improvement is found.

2. **Enlist various applications of iterative improvement method.**

- Simplex method.
- Matching graph vertices.
- Stable Marriage problem.
- Finding maximum network flow.

3. What is linear programming problem?

The standard form of linear programming is,

P=ax+by+cz

A Linear Programming (LP) problem is a problem in which we have to find the maximum (or minimum) value of a linear objective function.

4. Define bipartile graph.

The graph G=(V,E) in which the vertex set V is divided into two disjoint sets X and Y in such a way that every edge e belongs to E g=has one end point in X and other end point in Y.

5. Define Heap.

Heap is partially ordered data structure that is especially suitable for implementing priority queues. A heap is said to be a max heap, then the children of every node have a value less than that node. A heap is said to be a min heap, then the children of every node have a value greater than node

7. What is maximum matching problem?

The maximum matching problem is a problem of finding maximum matching in a graph.

8. Define augmenting path.

The augmenting path P is a path in graph G, such that it is an alternating path with special property that its start and end vertices are free or unmatched.

9. Define Floyd's algorithm?

- Floyd's algorithm is an application, which is used to find the entire pairs shortest paths problem.
- Floyd's algorithm is applicable to both directed and undirected weighted graph, but they do not contain a cycle of a negative length

10. How efficient is prim's algorithm?

The efficiency of the prim's algorithm depends on data structure chosen for the graph.

11. What is path compression?

The better efficiency can be obtained by combining either variation of quick union with path compression. Path compression makes every node encountered during the execution of a find operation point to the tree's node.

12. Define Dijkstra's Algorithm?

Dijkstra's algorithm solves the single source shortest path problem of finding shortest paths from a given vertex(the source), to all the other vertices of a weighted graph or digraph. Dijkstra's algorithm provides a correct solution for a graph with non negative weights.

13. When can we say that the optimal solution is obtained in simplex method?

When objective function is largest then the optimal solution is said to be obtained in simplex method.

14. What do you mean by Huffman code?

A Huffman code is a optimal prefix tree variable length encoding scheme that assigns bit strings to characters based on their frequencies in a given text.

15. What is meant by compression ratio?

Huffman's code achieves the compression ratio, which is a standard measure of compression algorithms effectiveness of

(3-2.25)/3*100 = 0.75/3*100 .

= 0.25 *100

= 25%.

16. List the advantage of Huffman's encoding?

Huffman's encoding is one of the most important file compression methods.

1. It is simple
2. It is versatility
3. It provides optimal and minimum length encoding

17. What is entering variable?

The entering variable is the smallest negative in the bottom most row of simplex table.

18. What do you mean by optimal solution?

Given problem with inputs, we obtain subset that satisfies come constraints. Any subset that satisfies these constraints is called a feasible solution. A feasible solution, which either maximizes or minimizes a given objective function, is called optimal solution.

19. Define the pivot element in the simplex method.

The intersection of entering variable's column and departing variables row is called pivot.

20. State the stable assignment problem.

Consider the two sets M= $\{m_1, m_2 \ldots m_n\}$ of n men and W= $\{w_1, w2 \ldots w_n\}$ of n women. Each man has a preference list ordering the women as potential marriage partners with no ties allowed. Similarly each woman has a preference list of the men, also with no ties. Then we have to find out the marriage matching pair (m, w) whose members are selected from these two sets based on their preferences.

UNIT –IV ITERATIVE IMPROVEMENT
PART-B

1. Descibe in detail about outline of simplex method
2. Explain geometric interpretation of Linear programming with example
3. Trace the simplex method on the following problems

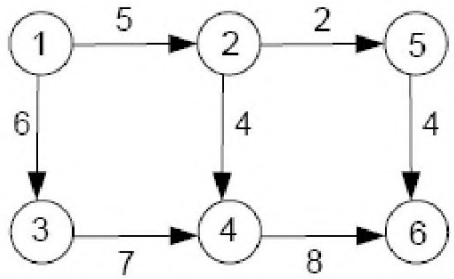
   Maximize p= 2x-3y=4z

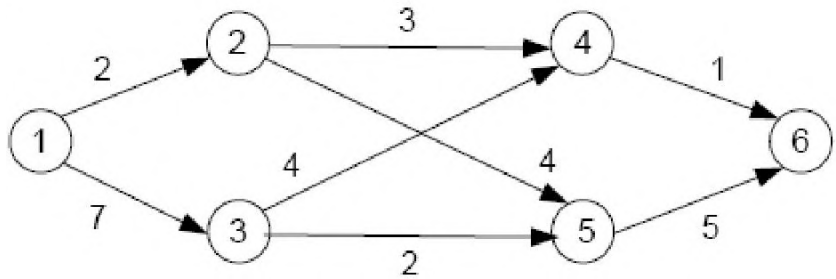
   Subject to 4x-3y+z<=3

   x+y+z <=10

   2x+y- z<=10 where x, y and z are non negative
4. Explain the maximum flow problem algorithm and prove the max Flow min cut theorem

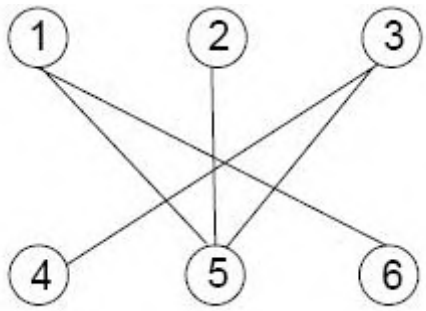
5. Apply the shortest augmenting path algorithm to find a maximum flow and minimum cut in the following network





6. Write the algorithm for maximum matching in Bipartite Graphs and prove the theorem with example

7. Apply the maximum matching algorithm to the following bipartite graphs



8. Explain the algorithm for stable marriage problem and prove the theorem with Example

9. Consider an instance of the stable marriage problem given by the ranking matrix

	A	B	C
α	1,3	2,2	3, 1
β	3,1	1,3	2, 2
γ	2,2	3,1	1, 3

For each of its marriage matching's, indicate whether it is stable or not

UNIT V COPING WITH THE LIMITATIONS OF ALGORITHM POWER
PART-A

1. Define backtracking.

Depth first node generation with bounding function is called backtracking. The backtracking algorithm has its virtue the ability to yield the answer with far fewer than m trials.

2. What is Hamiltonian cycle in an undirected graph?

A Hamiltonian cycle is round trip along n edges of G that visits every vertex once and returns to its starting position.

3. What is feasible solution?

It is obtained from given n inputs Subsets that satisfies some constraints are called feasible solution. It is obtained based on some constraints

4. What is optimal solution?

- It is obtained from feasible solution.
- Feasible solution that maximizes or minimizes a given objective function. It is obtained based on objective function.

5. Define decision tree.

All the sorting and searching algorithms are based on comparison method. The comparison is usually made on input items. A model is prepared to study the performance of such algorithms which is called decision tree.

6. Given an application for knapsack problem.

The knapsack problem is problem combinatorial optimization. It derives its name from the maximum problem of choosing possible essential that can fit too bag to be carried on trip. A similar problem very often appears business, combinatory, complexity theory, cryptography and applied mathematics.

7. Define subset sum problem.

Subset sum problem is problem, which is used to find a subset of a given set S={S1,S2,S3,…….Sn} of positive integers whose sum is equal to given positive integer d.

8. What is heuristic?

A heuristic is common sense rule drawn from experience rather than from mathematically proved assertion.

For example, going to the nearest unvisited city in the travelling salesman problem is good example for heuristic.

9. State the concept of branch and bound method.

The branch and bound method refers to all state space search methods in which all children of the E-Node are generated before any other live node can become the E-node.

10. Give the upper bound and lower bound of matrix multiplication algorithm.

Upper bound: The given algorithm does n*n*n multiplication hence at most n*n*n multiplication are necessary.

Lower bound: It has been proved in the literature that at least n*n multiplications are necessary.

11. What is state space tree?

Backtracking and branch bound are based on the construction of a state space tree, whose nodes

reflect specific choices made for a solution's component .Its root represents an initial state before the search for a solution begins.

The nodes of the first level the tree represent the made for the first component of solution; the nodes of the second even represent the Choices for the second components & so on.

12. What is promising and non promising node?

A node state space tree is said to be promising, if it corresponds to a partially constructed solution that may still lead to complete solution. Otherwise, node is called non- promising.

13. Enlist the applications of back tracking.

Eight queen problem
Sum of subset problem
Finding Hamiltonian path
Knapsack problem.

14. Differentiate backtracking and branch bound techniques.

1. Backtracking is applicable only to non optimization problems.
2. Backcktracking generates state space tree depth first manner.
3. Branch and bound is applicable only to optimization problem.
4. Branch and bound generated a node of state space tree using best first rule.

15. What is called all pair shortest path problem?

Given a weighted connected graph, the all pairs shortest paths problem is to find the distances from each vertex to all other vertices.

16. When do you say a tree as minimum spanning tree?

A spanning tree is said to be minimum spanning tree when the weight of the spanning tree is smallest, where the weight of a tree is defined as the sum of the weight of all its edges.

17. How will you construct an optimal binary search tree?

A binary search tree is one of the most important data structures in computer sciences. Its principal applications are to implement a dictionary, a set of elements with the operations of searching, insertion and deletion. If probabilities of searching for elements of a set are known as optimal binary search tree, for which the average number of comparisons in a sear h is the smallest possible.

18. What is the runtime of shortest path algorithm?

The runtime of shortest path algorithm is $\theta((n+|E|) \log n)$

19. What is mathematical modeling?

Mathematical modeling is method of ex pressing problem in terms of purely mathematical objects such as variables, functions and equations.

20. What is NP hard and NP completeness?

The NP hard problem is a class of problems in computational complexity that is as hard as the hardest problem in NP. If an NP hard problem can be solved in polynomial time then all the NP complete problems can also be solved in polynomial time.

NP completeness it belongs to class NP.

Every problem in NP can also solved in polynomial time.

21. List the two properties that must be satisfied by a problem L to be NP complete.

The problem L must be in NP.
All other problems in NP reduce to it.

UNIT –V COPING WITH THE LIMITATIONS OF ALGORITHM POWER
PART-B

1. Explain lower bound Arguments in detail.

2. Draw the Decision Tree and Find the number of Key Comparison in the worst and average case for:
   a. The four Element Binary search
   b. the Three-element basic insertion sort.

3. i)Describe in detail about P and NP Problems
   ii) Write short notes on NP Complete Problem

4. Write backtracking algorithm for
   a. The n-queens problem
   b. Hamiltonian problem
   c. The subset-Sum problem

5. Explain the Assignment problem in Branch and bound with Example.

6. Solve the following instance of Knapsack problem by Branch and bound Algorithm

Item	**weight**	**profit**
1	**5**	**$40**
2	**7**	**$35**
3	**2**	**$18 W=15**
4	**4**	**$4**
5	**5**	**$10**
6	**1**	**$2**

8.i)Describe in detail about Twice around the tree algorithm with example
   ii) Explain local search heuristic with example

9.Explain the knapsack problem using approximation algorithm with example.

V.S.B ENGINEERING COLLEGE, KARUR
DEPARTMENT OF INFORMATION TECHNOLOGY
EC 6504 & MICROPROCESSOR AND MICRO CONTROLLER
UNIT I – THE 8086 MICROPROCESSOR
PART-A

1. What is the data and address size in 8086?

The 8086 can operate on either 8-bit or 16-bit data. The 8086 uses 20 bit address to access memory and 16-bit address to access 1/0 devices.

2. Write the flags of 8086?

The 8086 has nine flags and they are

1. Carry Flag (CF) 6. Overflow Flag (OF)
2. Parity Flag (PF) 7. Trace Flag (TF)
3. Auxiliary carry Flag (AF) 8. Interrupt Flag (IF)
4. Zero Flag (ZF) 9. Direction Flag (DF)
5. Sign Flag (SF)

3. What are the interrupts of 8086?

The interrupts of 8086 are INTR and NMI. The INTR is general maskable interrupt and NMI is non-maskable interrupt.

4. Write the special functions carried by the general purpose registers of 8086?

The special functions carried by the registers of 8086 are the following.

Register Special function

1. AX 16-bit Accumulator
2. AL 8-bit Accumulator
3. BX Base Register
4. CX Count Register
5. DX .Data Register

5. Define pipelining?

In 8086, to speedup the execution of program, the instructions fetching and execution of instructions are overlapped each other. This technique is known as pipelining. In pipelining, when the n th instruction is executed, the n+1 th instruction is fetched and thus the processing speed is increased.

6. What are the functional units available in 8086 architecture?

The bus interface unit and execution unit are the two functional units available in 8086 architecture.

7. What is linker?

A linker is a program used to join together several object files into one large object file. For large programs it is more efficient to divide the large program modules into smaller modules. Each module is individually written, tested & debugged. When all the modules work they are linked together to form a large functioning program.

8. List the segment registers of 8086?

The segment registers of 8086 are Code segment, Data segment, Stack segment and Extra segment registers.

9. What is interrupt 1/0?

If the 1/0 device initiate the data transfer through interrupt then the 1/0 is called interrupt driven 1/0.

10. Explain ALIGN & ASSUME?

The ALIGN directive forces the assembler to align the next segment at an address divisible by specified divisor. The format is ALIGN number where number can be 2, 4, 8 or 16. Example ALIGN 8. The ASSUME directive assigns a logical segment to a physical segment at any given time. It tells the assembler what address will be in the segment registers at execution time. Example ASSUME CS: code, DS: data, SS: stack

11. Explain PTR & GROUP?

A program may contain several segments of the same type. The GROUP directive collects them under a single name so they can reside in a single segment, usually a data segment. The format is Name GROUP Seg-name,…..Seg-name

PTR is used to assign a specific type to a variable or a label. It is also used to override the declared type of a variable.

12. Explain about MODEL?

This directive provides short cuts in defining segments. It initializes memory model before defining any segment. The memory model can be SMALL, MEDIUM, COMPACT or LARGE.

Model	Code segments	Data segments
Small	One	One
Medium	Multiple	One
Compact	One	Multiple
Large	Multiple	Multiple

13. Explain PROC & ENDP?

PROC directive defines the procedures in the program. The procedure name must be unique. After PROC the term NEAR or FAR are used to specify the type of procedure. Example FACT PROC FAR. ENDP is used along with PROC and defines the end of the procedure.

14. Explain TITLE & TYPE?

The TITLE directive helps to control the format of a listing of an assembled program. It causes a title for the program to print on line 2 of each page of the program listing. Maximum 60 characters are allowed. Format TITLE text.

TYPE operator tells the assembler to determine the type of specified variable in bytes. bytes the assembler gives a value 1, for word 2 & double word 4.

15. Define SOP?

The segment override prefix allows the programmer to deviate from the default segment

Eg : MOV CS : [BX] , AL

16. Explain SEGMENT & ENDS?

An assembly program in .EXE format consists of one or more segments. The starts of these segments are defined by SEGMENT and the end of the segment is indicated by ENDS directive. Format Name SEGMENT Name ENDS

17. Define variable?

A variable is an identifier that is associated with the first byte of data item. In assembly language statement: COUNT DB 20H, COUNT is the variable.

18. What are procedures?

Procedures are a group of instructions stored as a separate program in memory and it is called from the main program whenever required. The type of procedure depends on where the procedures are stored in memory. If it is in the same code segment as that of main program then it is a near procedure otherwise it is a far procedure.

19. Explain the linking process?

A linker is a program used to join together several object files into one large object file. The linker produces a link file which contains the binary codes for all the combined modules. It also produces a link map which contains the address information about the link files. The linker does not assign absolute addresses but only relative address starting from zero, so the programs are relocatable & can be put anywhere in memory to be run.

20. Explain about passing parameters using registers with example?

Procedures process some data or address variable from the main program, for processing is necessary to pass the address variables or data. This is called passing parameters to procedures. In passing parameters using registers the data to be passed is stored in registers & these registers are accessed in the procedure to process the data.

```
CODE SEGMENT
MOV AL, DATA
CALL PRO1
PRO1 PROC NEAR
MOV INPUT, AL
RET
PRO1 ENDP
CODE ENDS
```

21. What is recursive procedures?

A recursive procedure is a procedure, which calls itself. Recursive procedures are used to work with complex data structures called trees. If the procedure is called with N=3, then the N is decremented by 1 after each procedure CALL and the procedure is called until N=0.

22. What are libraries?

Library files are collection of procedures that can be used in other programs. These procedures are assembled and compiled into a library file by the LIB program. The l file is invoked when a program is linked with linker program. when a library file is linked only the required procedures are copied into the program. Use of library files increase s/w reusability & reduce s/w development time.

23. What are Macros?

Macro is a group of instruction. The macro assembler generates the code in the program each time where the macro is called. Macros are defined by MACRO & ENDM. Creating macro is similar to creating new opcodes that can be used in the program

```
INIT MACRO
MOV AX, data
MOV DS
MOV ES, AX
```

24. How do 8086 interrupts occur?

An 8086 interrupt can come from any of the following three sources

External signals
Special instructions in the program
Condition produced by instruction

25. What are the 8086 interrupt types?

Dedicated interrupts

Type 0: Divide by zero interrupt
Type 1: Single step interrupt
Type 2:Non maskable interrupt
Type 3: Breakpoint
Type 4: Overflow interrupt
Type 0-255 Software interrupts

26. What is interrupt service routine?

Interrupt means to break the sequence of operation. While the CPU is executing a program an interrupt breaks the normal sequence of execution of instructions & diverts its execution to some other program. This program to which the control is transferred is called the interrupt service routine.

27. Define BIOS?

The IBM PC has in its ROM a collection of routines, each of which performs some specific function such as reading a character from keyboard, writing character to CRT. This collection of routines is referred to as Basic Input Output System or BIOS.

28. Explain PUBLIC?

For large programs several small modules are linked together. In order that the modules link together correctly any variable name or label referred to in other modules must be declared public in the module where it is defined. The PUBLIC directive is used to tell the assembler that a specified name or label will be accessed from other modules.

Format PUBLIC Symbol.

29. Explain DUP?

The DUP directive can be used to initialize several locations & to assign values to these locations. Format Name Data_Type Num DUP (value)

Example TABLE DW 10 DUP (0). Reserves an array of 10 words of memory and initializes all 10 words with 0. array name is TABLE.

30. What is the purpose of segment registers in 8086?

There are 4 segment registers present in 8086. They are

1. Code Segment (CS) register
2. Data Segment (DS) register
3. Stack Segment (SS) register
4. Extra Segment (ES) register

The code segment register gives the address of the current code segment. ie. It will points out where the instructions, to be executed, are stored in the memory.

The data segment register points out where the operands are stored in the memory.

The stack segment registers points out the address of the current stack, which is used to store the temporary results.

If the amount of data used is more the Extra segment register points out where the large amount of data is stored in the memory.

31. Discuss the function of instruction queue in 8086?

In 8086, a 6-byte instruction queue is presented at the Bus Interface Unit (BIU). It is used to prefetch and store at the maximum of 6 bytes of instruction code from the memory. to this, overlapping instruction fetch with instruction execution increases the processing speed.

32. What is the maximum memory size that can be addressed by 8086?

In 8086, an memory location is addressed by 20 bit address and the address bus is 20 bit address and the address bus is 20 bits. So it can address up to one mega byte (2^20) of memory space.

33. List the various addressing modes present in 8086?

There are 12 addressing modes present in 8086. They are,

(a) Register and immediate addressing modes
- Register addressing modes
- Immediate addressing mode

(b) Memory addressing modes.
- Direct addressing modes
- Register indirect addressing modes
- Based addressing modes
- Indexed addressing modes
- Based Indexed addressing modes
- String addressing modes

(c) I/O addressing modes
- Direct addressing mode
- Indirect addressing mode

(d) Relative addressing mode

(e) Implied addressing mode

34. How single stepping can be done in 8086?

By setting the Trace Flag (TF) the 8086 goes to single-step mode. In this mode, after the execution of each instruction s 8086 generates an internal interrupt and by writing some interrupt service routine we can display the content of desired registers and memory locations. So it is useful for debugging the program.

35. What are the functions of bus interface unit (BIU) in 8086?

(a) Fetch instructions from memory.

(b) Fetch data from memory and I/O ports.

(c) Write data to memory and I/O ports.

(d) To communicate with outside world.

(e) Provide external bus operations and bus control signals.

36. What is the clock frequency of 8086?

8086 8086-2 8086-4 Internal clock Frequency 5 MHz 8MHz 4MHz
External Clock Frequency 15MHZ 24MHZ 12MHZ

37. Explain REPEAT-UNTIL statements

REPEAT-UNTIL statements allow executing a series of instructions repeatedly until condition occurs. The REPEAT defines the start of the loop & UNTIL the end of the UNTIL has a condition when the condition is true the loop is terminated

38. Differentiate between absolute and linear select decoding?

Absolute decoding Linear decoding All higher address lines are defined to select the memory or I/O device Few higher address lines are decoded to select the memory or I/O device More h/w is required to design decoding logic Hardware required to design decoding logic is less Higher cost for decoding circuit Less cost for decoding circuit No multiple address Has a disadvantage of multiple addressing Used in large systems Used small systems

39. What are the three classifications of 8086 interrupts?

(1) Predefined interrupts
(2) User defined Hardware interrupts
(3) User defined software interrupts.

40. Explain the process control instructions

STC – It sets the carry flag & does not affect any other flag
CLC – it resets the carry flag to zero &does not affect any other flag
CMC – It complements the carry flag & does not affect any other flag
STD – It sets the direction flag to 1 so that SI and/or DI can be decremented automatically after execution of string instruction & does not affect other flags
CLD – It resets the direction flag to 0 so that SI and/or DI can be incremented automatically after execution of string instruction & does not affect other flags
STI – Sets the interrupt flag to 1. Enables INTR of 8086.
CLI – Resets the interrupt flagto0. 8086 will not respond to INTR.

41. Mention the addressing modes of the following 8086 instructions

MOV AL,disp[BX]; MOV AH,disp[BX][SI]
MOV AL,disp[BX]= Register relative addressing mode
MOV AH,disp[BX][SI] =Relative based indexed addressing mode.

42. What does it implies if the states of 8086 – BHE and A0 are at 0 ,1 respectively

When $\overline{BHE}$ =0 and A0 = 1, 8086 can access even byte address (D0-D7)

43. What is the addressing modes of the following instructions JMP 3001h,MOV AH,55H [BX][SI}

JMP 3001h inter segment indirect addressing mode
MOV AH, 55H [BX][SI} Relative based indexed addressing mode

44. What is the storage space required to store the interrupt vectors of 8086?

In 8086, 256 interrupt type's required (256X4) 1024 bytes storage space

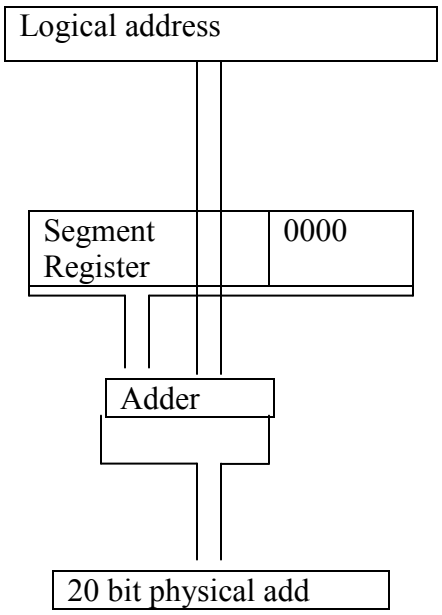
45. List any four Unconditional branch instructions

CALL, JMP, RET & LOOP

46. What is mean by software interrupt in 8086?

The software interrupts are program instructions. These instructions are inserted at desired locations in a program. While running a program, if a software interrupt is encountered then the processor executes on interrupt service routine(ISR).

47. How the 20 bit effective address is calculated in an 8086 processor



Effective address = (segment address x10H) +offset address

48. What is the function of T &D flags in 8086

D flag string direction flag; it is used set direction in string operation

T flag single step trap flag; it is used for single stepping through a program.

49. What is the operation carried out when 8086 executes instruction MOVSW

MOVSW-move word string this instruction Transfers a word from the source string (addressed by SI) to the destination string (addressed by DI) and updates SI and DI to point to the next string element.

50. What is the role of IF flag in the flag register of 8086?

If (Interrupt flag) setting IF causes the 8086 to receive external maskable interrupts through INTR pin. Clearing IF disables these interrupts

51. Name the signals used by 8086 to demultiplex the address/data bus.

The signals used by 8086 to demultiplex the address/data bus are $\overline{BHE}$, A0 and ALE.

52. What is the purpose of pointer and index registers?

The purpose of pointer is to point the address and string is referred to as pointers. The length is 16 bit long and responsible for memory addressing.

The index registers are source index and destination index.

53. What is the use of assume directive?

Assume directive is useful in defining a section of a program or a data array.

54. Define ISR.

Interrupt service routine

Tine is known as ISR. The starting address is referred as interrupt vector or 3 interrupt pointer. There are up to 256 interrupt vectors are available in the interrupt vector table.

55. Define an assembler?

It is a translator, to translate the ALP in to Machine language.
The execution time is less

56. Mention the flags of 8086.

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	OF	DF	IF	TF	S	Z	X	AC	X	P	X	C

57. What are the interrupts of 8086?

The interrupts of 8086 are INTR and NMI. The INTR is general mask able interrupt and NMI is non-mask able interrupt.

58. Mention the advantages of segmented memory organization.

Segmented memory structure is very much suitable for time-sharing computer system applications. Since, program code and data are stored in separate part of memory called segmented memory, switching from one task to another task by the system become easy. It is sufficient to store only 16 bit quantities of segment: Offset address values with in the registers of the processor, instead of 20bit quantities.

59. Mention the difference between NEAR CALL and FAR CALL statements.

If near call is used in the program means, it specifies that the call instruction and the call subroutine lie in the same segment. Far call defines that CALL instruction and the called subroutine lie in the different two segments.

60. What is the use of interrupt vector table (IVT) in 8086 processors?

8086 processor supports up to 256 interrupts. The interrupt vector table is used to hold starting addresses of these 256 interrupt service routines. Each ISR starting address occupies 4 memory locations within the interrupt vector table and the total size of this table will be 1 K bytes of memory.

61. Explain about DB, DW and DD directives.

DB, DW and DD directives are used to assign names for the values used with in the user program. DB is used for byte variables, DW and DD are used for word and double-word type of data's.

62. What is fetch and execute cycle?

In general, the instruction cycle of an instruction can be divided into fetch and execute cycles. The fetch cycle is executed to fetch the opcode from memory. The execute cycle executed to decode the instruction and to perform the work instructed by the instruction.

63. Define opcode and operand.

Opcode (Operation code) is the part of an instruction / directive that identifies a specific operation. Operand is a part of an instruction / directive that represents a value on which the instruction acts.

UNIT I THE 8086 MICROPROCESSOR
PART-B

1. Explain the internal hardware architecture of 8086 microprocessor with neat diagram?
2. Write short note about assembler directives?
3. Explain the various addressing modes of 8086 microprocessor with examples?
4. Explain Data transfer, arithmetic and branch instructions?
5. Write an 8086 ALP to find the sum of numbers in the array of 10 elements?
6. Explain modular programming in detail?
7. Write a note about stack, procedures and macros?
8. Define interrupt and their two classes? Write in detail about interrupt service routine?
9. Explain byte and string manipulation with examples?
10. Write in detail about instruction formats and instruction execution timing?
11. Write an ALP to find the largest number and smallest number in the array?
12. Describe in detail about the Procedures with suitable syntax and example.
13. Discuss about the interrupts and interrupt service routine with suitable sequence diagram.
14. Illustrate the Byte and String Manipulation of 8086 Instructions.
15. Write an 8086 assembly language program
    - multiply two 8 bit binary numbers.
    - sort an array of data in descending order.
    - add two 16 bit numbers
    - convert Binary to BCD number
    - add two 16 bit numbers to sort an array of data in ascending order.
    - convert BCD to Binary number
16. Write a short note about
    - Loop, NOP and HLT instructions
    - Flag manipulation, logical and shift & rotate instructions?

UNIT II – THE 8086 SYSTEM BUS STRUCTURE
PART-A

1. List the components of microprocessor (single board microcomputer)based system?

   The microprocessor based system consist of microprocessor as CPU, semiconductor memories like EPROM and RAM, input device, output device and interfacing devices.

2. Explain the function of M/IO in 8086?

   The signal M/IO is used to differentiate memory address and I/0 address When the processor is accessing memory locations MI/I0 is asserted high and when it is accessing I/0 mapped devices it is asserted low.

3. Why interfacing is needed for 1/0 devices?

   Generally I/O devices are slow devices. Therefore the speed of I/O devices does not match with the speed of microprocessor. And so an interface is provided between system bus and I/O devices.

4. What is the difference between CPU bus and system bus?

The CPU bus has multiplexed lines but the system bus has separate lines for each signal. (The multiplexed CPU lines are demultiplexed by the CPU interface circuit to form system bus).

5. What does memory-mapping mean?

The memory mapping is the process of interfacing memories to microprocessor and allocating addresses to each memory locations.

6. What is the function of the signal in 8086?

BHE signal means Bus High Enable signal. The BHE signal is made low when there is some read or write operation is carried out. ie . When ever the data bus of the system is busy i.e. whenever there is some data transfer then the BHE signal is made low.

7. State modes in which 8086 operates

Maximum mode and minimum mode.

8. State the significance of LOCK signal in 8086?

If 8086 is working at maximum mode, there are multiple multiprocessors are present. If the system bus is given to a processor then the LOCK signal is made low. That means the system bus is busy and it cannot be given of any other processors. After the use of the system bus again the LOCK signal is made high. That means it is ready to give the bus to any processor.

9. What is an interrupt driven I/O more efficient than programmed I/O for 8086 MP.

1)Interrupt I/O uses the built in interrupt capabilities

2) Interrupt I/O is asynchronous in nature

3) Programmed I/O is special I/O which is in full control data transfers. Using a software techniques called polling , the MP is synchronized to the speed of the PPI it is inefficient due to continuous states check

4) Processor response to the PPI only when ready and efficient became there is no need to poll the states

10. Give the function of the following 8086 CPU pins.

MN/$\overline{MX}$ – this pin configures CPU in minimum mode when strapped High and in maximum mode when strapped LOW.

LOCK- It locks the bus from being relinquished for DMA or other bus masters.

11. What is the function of TEST pin in 8086 processor?

TEST pin is used to check the software. If the TEST input is low, execution continues otherwise it waits until it goes to low.

12. Define Minimum mode operation.

This operation suited for single processor system. It offers 2Kx16EPROM and 1Kx16 static RAM. It also offers six 8-bit I/O ports.

13. Define Maximum mode operation.

This operation suited for multiprocessor system. 3 state signal used for the purpose of bus cycle status.

14. What is the purpose of latches?

Latches are used to store the address that is supplied to memory or I/O during the current machine cycle.

15. Advantages of minimum mode operation

Cheaper, Generate control signals, and I/O signals.

16. What is the advantages of 8086 processor?

Speed operation, Can solve complex problems

17. What are the basic multiprocessor configurations that the 8086 can support?

* Coprocessor configuration
* Closely coupled configuration
*Loosely configuration

18. What is multiprogramming?

If more than one process is carried out at the same time, then it is know as multiprogramming. Another definition is the interleaving of CPU and I/O operations among several programs is called multiprogramming. To improve the utilization of CPU and I/O devices, we are designing to process a set of independent programs concurrently by a single CPU. This technique is known as multiprogramming

19. What you mean by numeric processor?

8087 is the numeric or numeric co-processor. It adds arithmetic, trigonometric, exponential and logarithmic instructions to 8086 instruction set for all data types. It supports 16, 32, 64 bit integers, 32, 64, 80 bit floating point and 16 digit BCD data types.

20. Name the signals used by 8086 to control the data bus buffers.

In minimum mode of operation,
DT/R- data transmit/ receive
DEN – Data enable
In maximum mode of operation

$\overline{s2}$	$\overline{s1}$	$\overline{s0}$	Memory cycle
0	0	0	INTA
0	0	1	I/O read
0	1	0	I/O write
0	1	1	Halt
1	0	0	Code access
1	0	1	Memory read
1	1	0	Memory write
1	1	1	passive

21.Name the three bus allocation schemes used in loosely coupled multiprocessor system.

* Daisy chaining
* Polling method
* Independent Request

22. What are the advantages of a loosely coupled configuration in a multiprocessor system?

* Each processor may have a local bus to access local memory or / I/O devices so that a grater degree of parallel processing can be achieved.

* More flexible
* Better system throughput by having more than one processor.
* If any fault occurs in a module, that faulty module can be detected and replaced. So the breakdown of the entire system is avoidable.

UNIT II 8086 SYSTEM BUS STRUCTURE
PART-B

1. Explain Minimum mode and maximum mode of operation in 8086 in detail.
2. Explain in detail about the system bus timing of 8086/8088.
3. Write notes on Programmed I/O and Interrupt I/O
4. Explain in detail about block transfers and DMA.
5. Explain in detail about closely coupled configurations.
6. Explain loosely coupled configurations in detail.
7. Explain the following in detail
    - Process Management &iRMX86
    - Memory Management
    - Virtual Memory
8. Explain Numeric data Processor in detail.
9. Explain in detail about I/O Processor.
10. Explain in detail about 8086 memory banks and associated signals for byte and word operations.

11. Explain the various multiprocessor configurations.
12. Explain about System Bus Structure with suitable timing diagram.
13. Discuss in detail about Interrupt Priority Management.
14. Explain the various Bus Arbitration Schemes.
15. Explain in detail about Closely Coupled Configuration. Mention the Advantages and Disadvantages of the same.
16. Explain loosely coupled system with block diagram and list its advantages.
17. Discuss the principle and operations of co-Processor Configuration.

UNIT III – I/O INTERFACING
PART-A

1. Write a short note on INTEL 8255?

    The INTEL 8255 is a I/O port device consisting of 3 numbers of 8 –bit parallel I/O ports. The ports can be programmed to function either as a input port or as a output port in different operating modes. It requires 4 internal addresses and has one logic LOW chip select pin.

2. What is the drawback in memory mapped I/0?

    When I/O devices are memory mapped, some of the addresses are allotted to I/O devices and so the full address space cannot be used for addressing memory (i.e., physical memory address space will be reduced). Hence memory mapping is useful only for small systems, where the memory requirement is less.

3. What is masking and why it is required?

    Masking is preventing the interrupt from disturbing the current program execution. When the processor is performing an important job and if the process should not be interrupted then all the interrupts should be masked or disabled. In processor with multiple interrupts

the lower priority interrupt can be masked so as to prevent it from interrupting, the execution of interrupt service routine of higher priority interrupt.

4. What is DMA?

The direct data transfer between I/O device and memory is called DMA.

5. What is the need for Port?

The I/O devices are generally slow devices and their timing characteristics do not match with processor timings. Hence the I/O devices are connected to system bus through the ports.

6. What is a port?

The port is a buffered I/O, which is used to hold the data transmitted from the microprocessor to I/O device or vice-versa.

8. How DMA is initiated?

When the I/O device needs a DMA transfer, it will send a DMA request signal to DMA controller. The DMA controller in turn sends a HOLD request to the processor. When the processor receives a HOLD request, it will drive its tri-stated pins to high impedance state at the end of current instruction execution and send an acknowledge signal to DMA controller. Now the DMA controller will perform DMA transfer

9. What is Block and Demand transfer mode DMA?

In Block transfer mode, the DMA controller will transfer a block of data and relieve the bus for processor. After sometime another block of data is transferred by DMA and so on. In Demand transfer mode the DMA controller will complete the entire Data transfer at a stretch and then relieve the bus to processor.

10. Why status signals are provided in microprocessor?

The status signals can be used by the system designer to track the internal operations of the processor. Also, it can be used for memory expansion (by providing separate memory banks for program & data and selecting the bank using status signals).

11. What is vectored and Non- Vectored interrupt?

When an interrupt is accepted, if the processor control branches to a specific address defined by the manufacturer then the interrupt is called vectored interrupt.

In Non-vectored interrupt there is no specific address for storing the interrupt service routine. Hence the interrupted device should give the address of the interrupt service routine.

12. What is the function performed by DI instruction?

The function of Dl instruction is to enable the disabled interrupt system.

13. What is the function performed by EI instruction?

The El instruction can be used to enable the interrupts after disabling.

14. What is polling?

Polling is a scheme or an algorithm to identify the devices interrupting the processor. Polling is employed when multiple devices interrupt the processor through one interrupt pin of the processor.

15. What is the need for interrupt controller?

The interrupt controller is employed to expand the interrupt inputs. It can handle the interrupt request from various devices and allow one by one to the processor.

16. List some of the features of INTEL 8259 (Programmable Interrupt Controller)?

1. It manage eight interrupt request
2. The interrupt vector addresses are programmable.
3. The priorities of interrupts are programmable.
4. The interrupt can be masked or unmasked individually.

17. What is a programmable peripheral device?

If the functions performed by a peripheral device can be altered or changed by a program instruction then the peripheral device is called programmable device. Usually the programmable devices will have control registers. The device can be programmed by sending control word in the prescribed format to the control register.

18. What is synchronous data transfer scheme?

For synchronous data transfer scheme, the processor does not check the readiness of the device after a command has been issued for read/write operation. fu this scheme the processor will request the device to get ready and then read/W1.ite to the device immediately after the request. In some synchronous schemes a small delay is allowed the request.

19. What is asynchronous data transfer scheme?

In asynchronous data transfer scheme, first the processor sends a request to the device for read/write operation. Then the processor keeps on polling the status of the device. Once the device is ready, the processor executes a data transfer instruction to complete the process.

20. Explain the working of a handshake output port?

In handshake output operation, the processor will load a data to port. When the port receives the data, it will inform the output device to collect the data. Once the output device accepts the data, the port will inform the processor that it is empty. Now the processor can load another data to port and the above process is repeated.

21. What are the internal devices of 8255?

The internal devices of 8255 are port-A, port-B and port-C. The ports can be programmed for either input or output function in different operating modes.

22. What is baud rate?

The baud rate is the rate at which the serial data are transmitted. Baud rate is defined as l (The time for a bit cell). In some systems one bit cell has one data bit, then the baud rate and bits/sec are same.

23. What is USART?

The device which can be programmed to perform Synchronous or Asynchronous serial communication is called USART (Universal Synchronous Asynchronous Receiver Transmitter). The INTEL 8251A is an example of USART.

24. What are the functions performed by INTEL 8251A?

The INTEL 825lA is used for converting parallel data to serial or vice versa. The data transmission or reception can be either asynchronously or synchronously. The 8251A can be used to interface MODEM and establish serial communication through MODEM over telephone lines.

25. What are the control words of 8251A and what are its functions?

The control words of 8251A are Mode word and Command word. The mode word informs 8251 about the baud rate, character length, parity and stop bits. The command word can be send to enable the data transmission and reception.

26. What is the information that can be obtained from the status word of 8251?

The status word can be read by the CPU to check the readiness of the transmitter or receiver and to check the character synchronization in synchronous reception. It also provides information regarding various errors in the data received. The various error conditions that can be checked from the status word are parity error, overrun error and framing error.

27. What are the tasks involved in keyboard interface?

The task involved in keyboard interfacing are sensing a key actuation, Debouncing the and Generating key codes (Decoding the key). These task are performed software if the keyboard is interfaced through ports and they are performed by hardware if the keyboard is interfaced through 8279.

28. How a keyboard matrix is formed in keyboard interface using 8279?

The return lines, RLo to RL7 of 8279 are used to form the columns of keyboard matrix. decoded scan the scan lines SLo to SL3 of 8279 are used to form the rows of keyboard matrix. In encoded scan mode, the output lines of external decoder are used as rows of keyboard matrix.

29. What is scanning in keyboard and what is scan time?

The process of sending a zero to each row of a keyboard matrix and reading the columns for key actuation is called scanning. The scan time is the time taken by the processor to scan all the rows one by one starting from first row and coming back to the first row.

30. What is scanning in display and what is the scan time?

In display devices, the process of sending display codes to 7 –segment LEDs to display the LEDs one by one is called scanning (or multiplexed display). The scan time is the time taken to display all the 7-segment LEDs one by one, starting from first LED and coming back to the first LED again.

31. What are the modes of operation supported by 8255?

1. Simplex I/O mode
2. Strobed I/O mode
3. Bidirectional mode

32. List out three types of data transmission

1. Simplex
2. Half duplex
3. Full duplex

33. What is the usage of IRR

IRR is the register available in programmable interrupt controller. it is used to store all the interrupt levels which are requesting service. IRR is cascaded with in-service register.

34. What does it means LTM and SNGL bits are set to zero in ICW1 of 8259?

LTM=0; Edge triggered mode.
SNGL=0; cascading with other 8259's

35. What is key bouncing?

Key bouncing is the mechanical vibratory action of the contact making and breaking keys are pressed in keyboard. Key bounce can be confused as the rapid pressing of a key. Since the circuit is rapidly switching ON and OFF

36. What is the gate signal in 8254 timer?

The gate signal is used as the gate input of counters. CLK0.CLK1 gate signals are given counter0, counter1and counter 2 respectively.

37. List the features of 8251

1. It is a universal synchronous and asynchronous communication controller.
2. It supports standard asynchronous protocol with
   a.5 to 8 bit character format
   b.odd, even or no parity generation and detection
   c.automatic break detect and handling.
3. It has built in baud rate generator
4. It allows full duplex transmission
5. It provides error detection logic, which detectors parity, overrun and framing errors.
6. It has 28 pins; DIP package is available.

38. what is the internal operating frequency of the 8279?How can you derive it from any available clock signal?

The internal operating frequency of the 8279 is 100Khz. By dividing the available clock signal by the program clock word, it is obtained.

39. Name the modes of DMA operation.

Slave mode operation
Master mode operation

40. Name the six modes of operation of an 8253.. mode0- Interrupt on terminal count

Mode 1- Rate generator
Mode3- Square wave generator
Mode4- Software triggered mode
Mode5-Hardware triggered mode

41. Name any two important methods available for error correction during serial communication.

1.Parity bits
2.Check sum
3.Cyclic redundancy check

4.Hamming code with 4 bit parity to encode 8 bit of data

42. What is 'cascade buffer' in 8259?
It is a storage for the interrupt signals and comparing them.

43. What is SP/EN signal in 8259?
It is a slave program enable signal. A dual functional one, which ha 2 modes namely

UNIT III I/O INTERFACING
PART-B

1. Draw and explain the block diagram of 8254 programmable interval timer. Also explain the various modes of operation.
2. Explain 8279 keyboard /display controller with neat block diagram.
3. Explain how to interface ADC and DAC
4. With neat block diagram explain the 8251 and its operating modes.
5. Draw the block diagram of I/O interface &explain in detail.
6. Explain in detail about DMA controller.
7. Explain the format of I/O mode set control and BSR control word of programmable peripheral interface. Explain in detail the operating modes of PPI?
8. Draw and explain the block diagram of traffic light control system.
9. Write short notes on LED display, LCD display,Keyboard display interface.
10. Draw and explain the block diagram of alarm controller.
11. Compare serial and parallel interface?
12. Draw the Block diagram and explain the operations of 8255 Parallel communication interface.
13. Draw the Block diagram of 8279 and explain the functions of each block.
14. With a neat block diagram, explain the operation of 8259 programmable interrupt controller.
15. Discuss the features of Intel's programmable timer and explain its different modes of operation.

UNIT IV – MICROCONTROLLER
PART-A

1. Differentiate Microprocessors and Microcontrollers

Microprocessors	Microcontrollers
It has more op-codes It has few bit handling instructions Memory, I/O devices do not present. They may be connected externally.	It has less op-codes so programming is little bit easier. It has more bit handling instructions Memory, I/O devices present in a single chip.

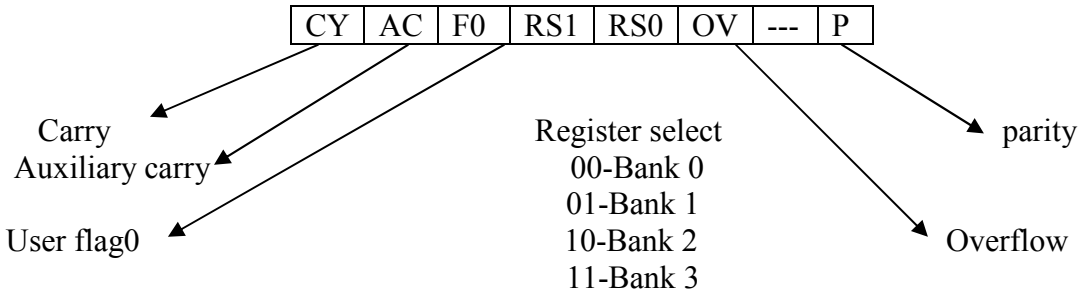
2. Name the interrupt sources of 8051 for which the priority levels are highest, lowest respectively.

1.IEO External Interrupt 0 Highest
2.TFO Timer Interrupt 0
3.IE1ExternalInterrupt1
4.TF1 Timer Interrupt 1

5.Serial port Interrupt R1or T1
Lowest

3. How does the status of EA pin affect the access to internal and external program memory?
If EA=0, 8051 can access the external program memory.
=1, accesses the internal program memory.

4. Draw the format of PSW of 8051.
Program status word (PSW)

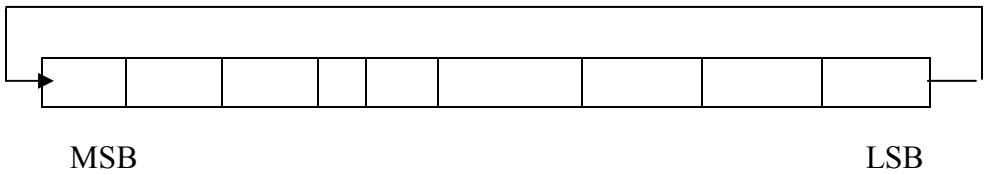


5. List the addressing mode supported by 8051.
1. Immediate addressing mode
2. Register addressing mode.
3. Direct addressing mode.
4. Register indirect addressing mode.
5. Indexed addressing mode.

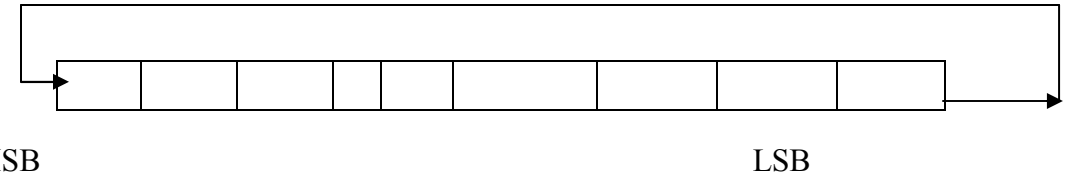
6. What are the register banks in 8051 MC?
Register Bank 0, Bank 1, Bank 2 & Bank 3.

7.What is baud rate?
Baud rate is used to indicate the rate at which data is being transferred.

8. Differentiate RRA and RRCA instructions in 8051 MC.
RRA : Rotate Accumulator Right.
Each binary bit of the accumulator is rotated right by one position. The LSB is placed in the position of MSB.



RRCA: Rotate Accumulator Right through carry.
Each binary bit of the accumulator is rotated right by one position through the carry flag. The LSB is placed in the carry flag the carry flag is placed in MSB.



9. What are the alternate functions of Port 3 in the 8051 MC?

P3.0-$\overline{RXD}$ P3.1-$\overline{TXD}$ P3.2-$\overline{INT0}$ P3.3-$\overline{INT1}$

P3.4-$\overline{T0}$ P3.5-$\overline{T1}$ P3.6-$\overline{WR}$ P3.7-$\overline{RD}$

10. What is the difference between timer and counter operation in 8051?

The timer counts the internal clock pulses whose frequency is ½ th of oscillator frequency.

The counter counts the internal clock pulses which are given through T0 pin and T1 pin of 8051.

11. What is the function of IP register in 8051?

The IP register is used to set high priority to one or more interrupt in 8051. Setting a bit to make the corresponding interrupt to have high priority and setting a bit 0 makes the corresponding interrupt to low priority.

IP Register

---	---	---	PS	PT1	PX1	PT0	PX0

12. What is the special function register available in 8051?

The 8051 operations that do not use the internal 128 byte RAM address from 00H to 7F H are done by a group of special internal registers, SFRs, which may be addressed like internal RAM.

13. What is the job of the TMOD register?

TMOD register is used to set the various timer operation modes. TMOD is dedicated solely to the two timers and can be considered to be two duplicate 4-bit registers, each of which controls the action of the timers.

14. What are the features of MC?

8 bit CPU with registers A and B
16 bit PC and DPTR
8 bit PSW
64 K Program memories.
64K Data memory
128 bytes of on chip data memory
32 I/O Pins for port 0, port1, Port2 & Port 3
2 16 bit timers, T0, T1.
Full duplex UART; SBUF
2 External and three internal sources.

15. Explain the operating mode 0 of 8051 serial port?

In this serial data enters and exits through RXD, TXD outputs the shift clock.8 bits are transmitted /received means 8 data bits. The baud rate is fixed at 1/12 the oscillator frequency.

16. Define machine cycle of 8051.

8051 machine cycle consists of 6 states, S1 through S6. One state is made up of two clock pulses. Thus 12 clock periods constitute one machine cycle. Two clock periods in a state is termed as phase 1 and phase2.what are the special function of Port 0 of 8051.Port 0 is used as a multiplexed low –order address on port 0 pins are latched and bus is ready to act as a data bus when ALE is low.

17. What happens in power down mode of 8051 MC?

The memory locations of power down RAM can be maintained through a separate small battery backup supply so that the content of these RAM can be preserved during power failure conditions.

18. What is the function of DPTR register?

The data pointer is the 16 bit address register that can be used to fetch any 8 bit data from the data memory space. When it is not being used for this purpose, it can be used as two eight bit registers, DPH and DPL.

19 What is the branching range when an AJMP/ACALL of 8051 instruction is executed?

2Kbytes.

20. What is mean by microcontroller?

A device which contains the microprocessor with integrated peripherals like memory, serial ports, parallel ports, timer/counter, interrupt controller, data acquisition interfaces like ADC, DAC is called microcontroller.

21. List the features of 8051 microcontroller?

The features are

*single supply +5 volt operation using HMOS technology.
*4096 bytes program memory on chip
*128 data memory on chip.
*Four register banks.
*Two multiple mode,16-bit timer/counter.
*Extensive boolean processing capabilities.
*64 KB external RAM size
*32 bidirectional individually addressible I/O lines.
*8 bit CPU optimized for control applications.

22. Explain the operating mode0 of 8051 serial ports?

In this mode serial enters &exits through RXD, TXD outputs the shift clock.8 bits are transmitted/received:8 data bits(LSB first).The baud rate is fixed at 1/12 the oscillator frequency.

23. Explain the operating mode2 of 8051 serial ports?

In this mode 11 bits are transmitted(through TXD)or received (through RXD):a start bit(0), 8 data bits(LSB first),a programmable 9th data bit ,& a stop bit(1).ON transmit the 9th data bit (TB* in SCON)can be assigned the value of 0 or 1.Or for eg:, the parity bit(P, in the PSW)could be moved into TB8.On receive the 9th data bit go in to the RB8 in Special Function Register SCON, while the stop bit is ignored. The baud rate is programmable to either 1/32or1/64 the oscillator frequency.

24. Explain the mode3 of 8051 serial ports?

In this mode,11 bits are transmitted(through TXD)or received(through RXD):a start bit(0), 8 data bits(LSB first),a programmable 9th data bit ,& a stop bit(1).In fact ,Mode3 is the same as Mode2 in all respects except the baud rate. The baud rate in Mode3 is variable. all the four modes, transmission is initiated by any instruction that uses SBUF as a destination register. Reception is initiated in Mode0 by the condition RI=0&REN=1.Reception is initiated in other modes by the incoming start bit if REN=1.

25. Explain the interrupts of 8051 microcontroller?

The interrupts are:

Vector address

- External interrupt 0 : IE0 : 0003H
- Timer interrupt 0 : TF0 : 000BH
- External interrupt 1 : IE1 : 0013H
- Timer Interrupt 1 : TF1 : 001BH
- Serial Interrupt

  Receive interrupt : RI : 0023H

  Transmit interrupt: TI : 0023H

26. List the addressing modes of 8051?

- Direct addressing
- Register addressing
- Register indirect addressing.
- Implicit addressing
- Immediate addressing
- Index addressing
- Bit addressing

27. Write about CALL statement in 8051?

There are two subroutine CALL instructions. They are

*LCALL(Long CALL)

*ACALL(Absolute CALL)

Each increments the PC to the 1st byte of the instruction & pushes them in to the stack.

28. Write about the jump statement?

There are three forms of jump. They are

LJMP(Long jump)-address 16

AJMP(Absolute Jump)-address 11

SJMP(Short Jump)-relative address

UNIT IV MICROCONTROLLER.
PART-B

1. Explain the architecture of 8051 with its diagram.
2. Explain the I/O pins ports and circuit details of 8051 with its diagram.
3. Write an 8051ALP to create a square wave 66%duty cycle on bit3 of port 1.
4. With example explain the arithmetic and logic instruction of 8051 microcontroller.

5. With example explain the different instruction set of 8051 microcontroller.
6. Write a program based on 8051 instruction set to pack array of unpacked BCD digits.
7. Explain the different addressing modes of 8051
8. Write a program to bring in data in serial form and send it out in parallel form using 8051
9. Explain the data types and assembler directives of 8051
10. Explain about the register banks and special function register of 8051 in detail
11. Write an Assembly Language Program using 8051,
    - Addition of two 8 bit Numbers
    - Addition of two 16 bit Numbers
12. Write an Assembly Language Program using 8051,
    - Multiplication of two data
    - Division of two data
13. Write an Assembly Language Program using 8051,
    - Finding 2's complement of a given binary number
    - Generate BCD up counter and send each count to port A
14. Write an Assembly Language Program using 8051,
    - Conversion of Binary to BCD number
    - To arrange a data in ascending order.
15. Explain the internal data memory structure of 8051 microcontroller with its SFRs.

UNIT V – INTERFACING MICROCONTROLLER
PART-A

1. Write A program to perform multiplication of 2 nos using 8051?

```
MOV A,#data 1
MOV B,#data 2
MUL AB
MOV DPTR,#5000
MOV @DPTR,A(lower value)
INC DPTR
MOV A,B
MOVX @ DPTR,A
```

2. Write a program to mask the 0th &7th bit using 8051?

```
MOV A,#data
ANL A,#81
MOV DPTR,#4500
MOVX @DPTR,A
LOOP SJMP LOOP
```

3. Write program to load accumulator , DPH & DPL using 8051?

```
MOV A,#30
MOV DPH,A
MOV DPL,A
```

4. Write a program to find the 2's complement using 8051?

```
MOV A,R0
CPL A
```

```
INC A
```

5. Write a program to add 2 8-bit numbers using 8051?

```
MOV A,#30H
ADD A,#50H
```

6. Write a program to swap two numbers using 8051?

```
MOV A, #data
SWAP A
```

7. Write a program to subtract 2 8-bit numbers &exchange the digits using 8051?

```
MOV A,#9F
MOV R0,#40
SUBB A,R0
SWAP A
```

8. Write a program to subtract the contents of R1 of Bank 0from the contents of R0 of Bank 2 using 8051?

```
MOV PSW,#10
MOV A,R0
MOV PSW,#00
SUBB A,R1
```

9. What is the need of ROM chips in microprocessor?

ROM chips are needed because of the execution of data by the instruction it has.

10. List some differences between main and secondary memory.

Main memory	Secondary memory
RAM,ROM are the primary memory devices	Floppy disc/Hard disk are the secondary memory devices
It is a volatile one	It is non -volatile one
Limited memory capacity	Unlimited memory capacity

11. What do you mean by volatile?

The data can not be retained, even if the power is turned off, then it is called as volatile.

12. What do you mean by non-volatile

The data can be retained, even if the power is turned off, then it is called as non-volatile. Floppy disc, hard disc are some of the non-volatile devices(secondary storage devices).

13. Distinguish RAM & ROM.

RAM	ROM
It is a Read /Write memory	It is a Read only momory
It is high speed memory	It is low speed memory
It is volatile in nature	It is non-volatile in nature.

14. List the interrupts of8051 microcontrollers.

Two interrupts are triggered by external signals provided by the circuitry that is connected to pins INTO bar/ INTI bar.

15. What are nested interrupts?

The8051is executing an ISR for servicing an interrupt and another interrupt occurs. If the

new coming interrupt is high priority interrupt, then only it can interrupt the previously occurred low-priority interrupt. These are called nested interrupts.

16. Write short notes on interrupt priority.

Bit set to1 gives the accompanying interrupt a high priority, a0 assign slow priority, interrupts with the highest priority can interrupt another interrupt with a lower priority; the lower priority interrupt continues after the higher is finished. If two interrupts with the same priority occur at the same time, them they have the following ranking:
1.IEO 2.TFO 3.IE1 4.TFI 5.Serial =RI or TFI.

17. What are the usage of Timer and Converter?

Timer is used to convert the machine cycles and count rate is$1/12^{th}$ of the oscillator frequency. In counter mode, counter is incremented for1to 0 transition and it has maximum count rate as$1/24^{th}$of oscillator frequency.

18. What are the features of ROM and RAM in 8051 microcontroller?

ROM: The 8051 has internal ROM of 4KB starting from 0000H to 0FFFH. This ROM shares same address with internal RAM but the data paths are different for both following the hardware architecture. The internal ROM is in program memory space. All instruction fetches are taken from program memory.

UNIT V INTERFACING MICROCONTROLLER
PART-B

1. Draw the diagram to interface a stepper motor with 8051 microcontroller and explain also write an 8051 ALP to run the stepper motor in both forward and reverse direction with delay.
2. Explain how interrupts are handled in 8051.
3. Write short notes on LCD interface.
4. Write notes on 8051 serial port programming.
5. Explain about external memory interfacing to 8051
6. Write notes on 8051 timer and counter programming.
7. Draw and explain the ADC interfacing using 8051.
8. Draw and explain the DAC interfacing using 8051.
9. Explain the keyboard interfacing using 8051
10. Explain the sensor interfacing using 8051
11. How to transfer data between a PC and microcontroller using serial communication? Draw the necessary diagrams and explain.
12. Explain about interfacing of waveform generator with 8051 Microcontroller.
13. Explain in detail about Keyboard interfacing with 8051.
14. Explain about the Timers of 8051 with its Modes of Operation. Also explain about the Registers of 8051 Timers.
15. What are the interrupts available in 8051? Explain about the Interrupt Structure.

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF INFORMATION TECHNOLOGY
CS6403- SOFTWARE ENGINEERING
UNIT I
SOFTWARE PROCESS AND PROJECT MANAGEMENT
PART-A

1. What is software engineering?
Software engineering is a discipline in which theories, methods and tools are applied to develop professional software.

2. What is Software?
Software is nothing but a collection of computer programs that are related documents that are indented to provide desired features, functionalities and better performance.

3. What are the characteristics of the software?
- Software is engineered, not manufactured.
- Software does not wear out.
- Most software is custom built rather than being assembled from components.

4. What are the various categories of software?
- System software
- Application software
- Engineering/Scientific software
- Embedded software
- Web Applications
- Artificial Intelligence software

5. What are the challenges in software?
- Copying with legacy systems.
- Heterogeneity challenge
- Delivery times challenge

6. Define software process.
Software process is defined as the structured set of activities that are required to develop the software system.

7. What are the fundamental activities of a software process?
- Specification
- Design and implementation
- Validation
- Evolution

8. What are the umbrella activities of a software process?
- Software project tracking and control.
- Risk management.

- Software Quality Assurance.
- Formal Technical Reviews.
- Software Configuration Management.
- Work product preparation and production.
- Reusability management.
- Measurement.

9. What are the merits of incremental model?

i. The incremental model can be adopted when tere are less number of people involved in the project.

ii. Technical risks can be managed with each increment.

iii. For a very small time span,at least core product can be delivered to the customer.

10. List the task regions in the Spiral model.

- **Customer communication –** In this region it is suggested to establish customer communication.
- **Planning –** All planning activities are carried out in order to define resources timeline and other project related activities.
- **Risk analysis –** The tasks required to calculate technical and management risks.
- **Engineering –** In this the task region tasks required to build one or more representations of applications are carried out.
- **Construct and release –** All the necessary tasks required to construct,test,install the applications are conducted.
- **Customer evaluation –** Customer‟s feedback is obtained and based on the customer evaluation required tasks are performed and implemented at installation stage.

11. What are the drawbacks of spiral model?

i. It is based on customer communication.If the communication is not proper then the software product that gets developed will not be the up to the mark.

ii. It demands considerable risk assessment.If the risk assessment is done properly then only the successful product can be obtained.

12. What is System Engineering?

System Engineering means designing,implementing,deploying and operating systems which include hardware,software and people.

13. List the process maturity levels in SEIs CMM.

Level 1:Initial – Few processes are defined and individual efforts are taken.

Level 2:Repeatable – To track cost schedule and functionality basic project management processes are established.

Level 3:Defined – The process is standardized, documented and followed.

Level 4:Managed – Both the software process and product are quantitatively understood
and controlled using detailed measures.

Level 5:Optimizing – Establish mechanisms to plan and implement change.

14. What is an effector process?

The effector process is a process that verifies itself.The effector process exists in certain criteria.

15. Define the computer based system.

The computer based system can be defined as "a set or an arrangement of elements that are organized to accomplish some predefined goal by processing information".

16. What does Verification represent?

Verification represents the set of activities that are carried out to confirm that the software correctly implements the specific functionality.

17. What does Validation represent?

Validation represents the set of activities that ensure that the software that has been built is satisfying the customer requirements.

18. What are the steps followed in testing?

i. **Unit testing –** The individual components are tested in this type of testing.
ii. **Module testing –** Related collection of independent components are tested.
iii. **Sub-system testing –** This is a kind of integration testing. Various modules are integrated into a subsystem and the whole subsystem is tested.
iv. **System testing –** The whole system is tested in this system.
v. **Acceptance testing –** This type of testing involves testing of the system with customer data. If the system behaves as per customer need then it is accepted.

19. What is the use of CMM?

Capability Maturity Model is used in assessing how well an organization's processes allow to complete and manage new software projects.

20. Name the Evolutionary process Models.

i. Incremental model
ii. Spiral model
iii. WIN-WIN spiral model
iv. Concurrent Development

21. What is requirement engineering?

Requirement engineering is the process of establishing the services that the customer requires from the system and the constraints under which it operates and is developed.

22. What are the various types of traceability in software engineering?

i. Source traceability – These are basically the links from requirement to stakeholders who propose these requirements.
ii. Requirements traceability – These are links between dependant requirements.
iii. Design traceability – These are links from requirements to design.

UNIT I SOFTWARE PROCESS AND PROJECT MANAGEMENT
PART-B

1.Explain iterative waterfall and spiral model for software life cycle and various activities in each phase.
2.Explain about the incremental model.
3. Explain in detail about the software process
4.Explain in detail about the life cycle process.

UNIT II
REQUIREMENTS ANALYSIS AND SPECIFICATION
PART-A

1. **Define software prototyping.**

Software prototyping is defined as a rapid software development for validating the requirements.

2. **What are the benefits of prototyping?**

i. Prototype serves as a basis for deriving system specification.
ii. Design quality can be improved.
iii. System can be maintained easily.
iv. Development efforts may get reduced.
v. System usability can be improved.

3. **What are the prototyping approaches in software process?**

i. Evolutionary prototyping – In this approach of system development, the initial prototype is prepared and it is then refined through number of stages to final stage.
ii. Throw-away prototyping – Using this approach a rough practical implementation of the system is produced. The requirement problems can be identified from this implementation. It is then discarded. System is then developed using some different engineering paradigm.

4. **What are the advantages of evolutionary prototyping?**

i. Fast delivery of the working system.
ii. User is involved while developing the system.
iii. More useful system can be delivered.
iv. Specification,design and implementation work in co-ordinate manner.

5. **What are the various Rapid prototyping techniques?**

i. Dynamic high level language development.
ii. Database programming.
iii. Component and application assembly.

6. **What is the use of User Interface prototyping?**

This prototyping is used to pre-specify the look and feel of user interface in an effective way.

7. **What are the characteristics of SRS?**

i. Correct – The SRS should be made up to date when appropriate requirements are identified.
ii. Unambiguous – When the requirements are correctly understood then only it is possible to write an unambiguous software.

iii. **Complete –** To make SRS complete, it should be specified what a software designer wants to create software.

iv. **Consistent –** It should be consistent with reference to the functionalities identified.

v. **Specific –** The requirements should be mentioned specifically.

vi. **Traceable –** What is the need for mentioned requirement? This should be correctly identified.

8. What are the objectives of Analysis modeling?

i. To describe what the customer requires.
ii. To establish a basis for the creation of software design.
iii. To devise a set of valid requirements after which the software can be built.

9. What is data modeling?

Data modeling is the basic step in the analysis modeling. In data modeling the data objects are examined independently of processing. The data model represents how data are related with one another.

10. What is a data object?

Data object is a collection of attributes that act as an aspect, characteristic, quality, or descriptor of the object.

11. What are attributes?

Attributes are the one, which defines the properties of data object.

12. What is cardinality in data modeling?

Cardinality in data modeling, cardinality specifies how the number of occurrences of one object is related to the number of occurrences of another object.

13. What does modality in data modeling indicates?

Modality indicates whether or not a particular data object must participate in the relationship.

14. What is ERD?

Entity Relationship Diagram is the graphical representation of the object relationship pair. It is mainly used in database applications.

15. What is DFD?

Data Flow Diagram depicts the information flow and the transforms that are applied on the data as it moves from input to output.

16. What does Level0 DFD represent?

Level0 DFD is called as „fundamental system model‟ or „context model‟. In the context model the entire software system is represented by a single bubble with input and output indicated by incoming and outgoing arrows.

17. What is a state transition diagram?

State transition diagram is basically a collection of states and events. The events cause the system to change its state. It also represents what actions are to be taken on the occurrence of particular event.

18. Define Data Dictionary.

The data dictionary can be defined as an organized collection of all the data elements of the system with precise and rigorous definitions so that user and system analyst will have a common understanding of inputs, outputs, components of stores and intermediate calculations.

19. What are the elements of Analysis model?

i. Data Dictionary
ii. Entity Relationship Diagram
iii. Data Flow Diagram
iv. State Transition Diagram

UNIT – II REQUIREMENTS ANALYSIS AND SPECIFICATION
PART-B

1. Explain the prototyping approaches in software process.

2. Explain about rapid prototyping techniques. Executable specification languages.

3. Explain in detail about data modeling.

4. Explain in detail about Functional Modeling.

5. Explain in detail about Structural Modeling.

UNIT III
SOFTWARE DESIGN
PART-A

1. What are the elements of design model?

i. Data design
ii. Architectural design
iii. Interface design
iv. Component-level design

2. Define design process.

Design process is a sequence of steps carried through which the requirements are translated into a system or software model.

3. List the principles of a software design.

i. The design process should not suffer from “tunnel vision”.
ii. The design should be traceable to the analysis model.
iii. The design should exhibit uniformity and integration.
iv. Design is not coding.
v. The design should not reinvent the wheel.

4. **What is the benefit of modular design?**
   Changes made during testing and maintenance becomes manageable and they do not affect other modules.

5. **What is a cohesive module?**
   A cohesive module performs only "one task" in software procedure with little interaction with other modules. In other words cohesive module performs only one thing.

6. **What are the different types of Cohesion?**
   i. **Coincidentally cohesive –**The modules in which the set I\of tasks are related with each other loosely then such modules are called coincidentally cohesive.
   ii. **Logically cohesive –** A module that performs the tasks that are logically related with each other is called logically cohesive.
   iii. **Temporal cohesion –** The module in which the tasks need to be executed in some specific time span is called temporal cohesive.
   iv. **Procedural cohesion –** When processing elements of a module are related with one another and must be executed in some specific order then such module is called procedural cohesive.
   v. **Communicational cohesion –** When the processing elements of a module share the data then such module is called communicational cohesive.

7. **What is Coupling?**
   Coupling is the measure of interconnection among modules in a program structure. It depends on the interface complexity between modules.

8. **What are the various types of coupling?**
   i. **Data coupling –** The data coupling is possible by parameter passing or data interaction.
   ii. **Control coupling –** The modules share related control data in control coupling.
   iii. **Common coupling –** The common data or a global data is shared among modules.
   iv. **Content coupling** – Content coupling occurs when one module makes use of data or control information maintained in another module.

9. **What are the common activities in design process?**
   i. **System structuring** – The system is subdivided into principle subsystems components and communications between these subsystems are identified.
   ii. **Control modeling –** A model of control relationships between different parts of the system is established.
   iii. **Modular decomposition –** The identified subsystems are decomposed into modules.

10. **What are the benefits of horizontal partitioning?**
    i. Software that is easy to test.
    ii. Software that is easier to maintain.
    iii. Propagation of fewer sideeffects.
    iv. Software that is easier to extend.

11. **What is vertical partitioning?**

Vertical partitioning often called factoring suggests that the control and work should be distributed top-down in program structure.

12. What are the advantages of vertical partitioning?

i. These are easy to maintain changes.
ii. They reduce the change impact and error propagation.

13. What are the various elements of data design?

i. Data object – The data objects are identified and relationship among various data objects can be represented using ERD or data dictionaries.
ii. Databases – Using software design model, the data models are translated into data structures and data bases at the application level.
iii.Data warehouses – At the business level useful information is identified from various databases and the data warehouses are created.

14. List the guidelines for data design.

i. Apply systematic analysis on data.
ii. Identify data structures and related operations.
iii. Establish data dictionary.
iv. Use information hiding in the design of data structure.
v. Apply a library of useful data structures and operations.

15. Name the commonly used architectural styles.

i. Data centered architecture.
ii. Data flow architecture.
iii. Call and return architecture.
iv. Object-oriented architecture.
v. Layered architecture.

16. What is Transform mapping?

The transform mapping is a set of design steps applied on the DFD in order to map the transformed flow characteristics into specific architectural style.

17. What is a Real time system?

Real time system is a software system in which the correct functionalities of the system are dependent upon results produced by the system and the time at which these results are produced.

18. What is SCM?

Software Configuration Management is a set of activities carried out for identifying, organizing and controlling changes throughout the lifecycle of computer software.

19. What is SCI?

Software Configuration Item is information that is carried as part of the software engineering process.

UNIT III SOFTWARE DESIGN
PART-B

1. Explain in detail the design concepts. Abstraction

2. Explain the design principles.

3. Explain the design steps of the transform mapping.

4. Explain the design steps in transaction mapping.

5. Explain in detail about the real time systems.

UNIT IV
TESTING AND IMPLEMENTATION
PART-A

1. **Define software testing?**
   Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design, and coding.

2. **What are the objectives of testing?**
   i. Testing is a process of executing a program with the intend of finding an error.
   ii. A good test case is one that has high probability of finding an undiscovered error.
   iii. A successful test is one that uncovers as an-yet undiscovered error.

3. **What are the testing principles the software engineer must apply while performing the software testing?**
   i. All tests should be traceable to customer requirements.
   ii. Tests should be planned long before testing begins.
   iii. The pareto principle can be applied to software testing-80% of all errors uncovered during testing will likely be traceable to 20% of all program modules.
   iv. Testing should begin "in the small" and progress toward testing "in the large".
   v. Exhaustive testing is not possible.
   vi. To be most effective, an independent third party should conduct testing.

4. **What are the two levels of testing?**
   i. Component testing Individual components are tested. Tests are derived from developer"s experience.
   ii. System Testing The group of components are integrated to create a system or sub- system is done. These tests are based on the system specification.

5. **What are the various testing activities?**
   i. Test planning

ii. Test case design
iii. Test execution
iv. Data collection
v. Effective evaluation

6. Write short note on black box testing.

The black box testing is also called as behavioral testing. This method fully focuses on the functional requirements of the software. Tests are derived that fully exercise all functional requirements.

7. What is equivalence partitioning?

Equivalence partitioning is a black box technique that divides the input domain into classes of data. From this data test cases can be derived. Equivalence class represents a set of valid or invalid states for input conditions.

8. What is a boundary value analysis?

A boundary value analysis is a testing technique in which the elements at the edge of the domain are selected and tested. It is a test case design technique that complements equivalence partitioning technique. Here instead of focusing on input conditions only, the test cases are derived from the output domain.

9. What are the reasons behind to perform white box testing?

There are three main reasons behind performing the white box testing.

1. Programmers may have some incorrect assumptions while designing or implementing some functions.Due to this there are chances of having logical errors in the program.To detect and correct such logical errors procedural details need to be examined.

2. Certain assumptions on flow of control and data may lead programmer to make design errors.To uncover the errors on logical path,white box testing is must.

3. There may be certain typographical errors that remain undetected even after syntax and type checking mechanisms.Such errors can be uncovered during white box testing.

10. What is cyclomatic complexity?

Cyclomatic complexity is a software metric that gives the quantitative measure of logical complexity of the program. The Cyclomatic complexity defines the number of independent paths in the basis set of the program that provides the upper bound for the number of tests that must be conducted to ensure that all the statements have been executed at least once.

11. How to compute the cyclomatic complexity?

The cyclomatic complexity can be computed by any one of the following ways.

1. The numbers of regions of the flow graph correspond to the cyclomatic complexity.
2. Cyclomatic complexity,V(G),for the flow graph,G,is defined as: V(G)=E-N+2,

E -- number of flow graph edges, N -- number of flow graph nodes

3. V(G)=P+1 Where P is the number of predicate nodes contained in the flow graph.

12. Distinguish between verification and validation.

Verification refers to the set of activities that ensure that software correctly implements a specific function.

Validation refers to a different set of activities that ensure that the software that has been built is traceable to the customer requirements.

According to Boehm,

- Verification:" Are we building the product right?"
- Validation:" Are we building the right product?"

13. What are the various testing strategies for conventional software?

i. Unit testing ii. Integration testing.
iii. Validation testing. iv. System testing.

14. Write about drivers and stubs.

Drivers and stub software need to be developed to test incompatible software.

- The " **driver**" is a program that accepts the test data and prints the relevant results.
- The " **stub**" is a subprogram that uses the module interfaces and performs the minimal data manipulation if required.

15. What are the approaches of integration testing?

The integration testing can be carried out using two approaches.

1. The non-incremental testing.
2. Incremental testing.

16. What are the advantages and disadvantages of big-bang? Advantages:

- This approach is simple.

Disadvantages:

- It is hard to debug.
- It is not easy to isolate errors while testing.
- In this approach it is not easy to validate test results.
- After performing testing, it is impossible to form an integrated system.

17. What are the benefits of smoke testing?

- Integration risk is minimized.
- The quality of the end-product is improved.
- Error diagnosis and correction are simplified.
- Assessment of program is easy.

18. What are the conditions exists after performing validation testing?

After performing the validation testing there exists two conditions.

- The function or performance characteristics are according to the specifications and are accepted.
- The requirement specifications are derived and the deficiency list is created. The deficiencies then can be resolved by establishing the proper

communication with the customer.

19. Distinguish between alpha and beta testing.

- Alpha and beta testing are the types of acceptance testing.
- **Alpha test**: The alpha testing is attesting in which the version of complete software is tested by the customer under the supervision of developer. This testing is performed at developer‟s site.
- **Beta test**: The beta testing is a testing in which the version of the software is tested by the customer without the developer being present. This testing is performed at customer‟s site.

20. What are the various types of system testing?

1. **Recovery testing** – is intended to check the system‟ s ability to recover from failures.
2. **Security testing –** verifies that system protection mechanism prevent improper penetration or data alteration.
3. **Stress testing –** Determines breakpoint of a system to establish maximum service level.
4. **Performance testing –** evaluates the run time performance of the software, especially real-time software.

21. Define debugging.

Debugging is defined as the process of removal of defect. It occurs as a consequence of successful testing.

22. What are the common approaches in debugging?

- **Brute force method:** The memory dumps and run-time tracks are examined and program with write statements is loaded to obtain clues to error causes.
- **Back tracking method:** The source code is examined by looking backwards from symptom to potential causes of errors.
- **Cause elimination method:** This method uses binary partitioning to reduce the number of locations where errors can exists.

23. Write about the types of project plan.

- **Quality plan –** This plan describes the quality procedures and standards that will be used in a project.
- **Validation plan –** This plan describes the approach, resources and schedule required for system validation.
- **Configuration management plan –** This plan focuses on the configuration management procedures and structures to be used.
- **Maintenance plan –** The purpose of maintenance plan is to predict the maintenance requirements of the system, maintenance cost and efforts required.
- **Staff development plan –** This plan describes how to develop the skills and experience of the project team members.

UNIT-IV TESTING AND IMPLEMENTATION
PART-B

1. Explain the types of software testing.

2. Explain in detail about Black box testing.

3. Explain about the software testing strategies.

4. Explain in detail about Integration testing.

5. Explain in detail about system testing.

6. Explain in detail about SCM.

UNIT V
PROJECT MANAGEMENT
PART-A

1. **Define measure.**

Measure is defined as a quantitative indication of the extent, amount, dimension, or size of some attribute of a product or process.

2. **Define metrics.**

Metrics is defined as the degree to which a system component, or process possesses a given attribute.

3. **What are the types of metrics?**

- **Direct metrics –** It refers to immediately measurable attributes. Example – Lines of code, execution speed.
- **Indirect metrics –** It refers to the aspects that are not immediately quantifiable or measurable. Example – functionality of a program.

4. **What are the advantages and disadvantages of size measure? Advantages:**

- Artifact of software development which is easily counted.
- Many existing methods use LOC as a key input.
- A large body of literature and data based on LOC already exists.

Disadvantages:

- This method is dependent upon the programming language.
- This method is well designed but shorter program may get suffered.
- It does not accommodate non procedural languages.
- In early stage of development it is difficult to estimate LOC.

5. **Write short note on the various estimation techniques.**

- **Algorithmic cost modeling –** the cost estimation is based on the size of the software.
- **Expert judgement –** The experts from software development and the application domain use their exoerience to predict software costs.

- E**stimation by analogy –** The cost of a project is computed by comparing the project to a similar project in the same application domain and then cost can be computed.
- **Parkinson's law –** The cost is determined by available resources rather than by objective assessment.
- **Pricing to win –** The project costs whatever the customer ready to spend it.

6. What is COCOMO model?

Constructive COst MOdel is a cost model, which gives the estimate of number of man- months it will take to develop the software product.

7. Give the procedure of the Delphi method.

1. The co-ordinator presents a specification and estimation form to each expert.
2. Co-ordinator calls a group meeting in which the experts discuss estimation issues with the coordinator and each other.
3. Experts fill out forms anonymously.
4. Co-ordinator prepares and distributes a summary of the estimates.
5. The Co-ordinator then calls a group meeting.In this meeting the experts mainly discuss the points where their estimates vary widely.
6. The experts again fill out forms anonymously.
7. Again co-ordinator edits and summarizes the forms,repeating steps 5 and 6 until the co-ordinator is satisfied with the overallprediction synthesized from experts.

8. What is the purpose of timeline chart?

The purpose of the timeline chart is to emphasize the scope of the individual task. Hence set of tasks are given as input to the timeline chart.

9. What is EVA?

Earned Value Analysis is a technique of performing quantitative analysis of the software Project.It provides a common value scale for every task of software project.It acts as a measure for software project progress.

10. What are the metrics computed during error tracking activity?

- Errors per requirement specification page.
- Errors per component-design level
- Errors per component-code level
- DRE-requirement analysis
- DRE-architectural analysis
- DRE-component level design
- DRE-coding.

11. Why software change occurs?

Software change occurs because of the following reasons. ¾_New requirements emerge when the software is used. ¾_The business environment changes. ¾_Errors need to be repaired. ¾_New equipment must be accommodated. ¾_The performance or

reliability may have to be improved.

12. Write about software change strategies.

The software change strategies that could be applied separately or together are:

a. **Software maintenance –** The changes are made in the software due to requirements.
b. **Architectural transformation –** It is the process of changing one architecture into another form.
c. **Software re-engineering –** New features can be added to existing system and then the system is reconstructed for better use of it in future.

13. What is software maintenance?

Software maintenance is an activity in which program is modified after it has been put into use.

14. What are the types of software maintenance?

d. **Corrective maintenance –** Means the maintenance for correcting the software faults.
e. **Adaptive maintenance –** Means maintenance for adapting the change in environment.
f. **Perfective maintenance –** Means modifying or enhancing the system to meet the new requirements.
g. **Preventive maintenance –** Means changes made to improve future maintainability.

15. What is architectural evolution?

Architectural evolution is the process of changing a system from a centralized architecture to a distributed architecture like client server.

16. How the CASE tools are classified?

CASE tools can be classified by

a. By function or use
b. By user type(e.g. manager, tester),or
c. By stage in software engineering process (e.g.requirements,test).

17. What are the types of static testing tools?

There are three types of static testing tools.

- **Code based testing tools –** These tools take source code as input and generate test cases.
- **Specialized testing tools –** Using this language the detailed test specification can be written for each test case.
- **Requirement-based testing tools –** These tools help in designing the test cases as per user requirements.

UNIT V PROJECT MANAGEMENT
PART-B

1. Explain about software cost estimation.
2. Explain in detail about COCOMO model.
3. Explain in detail about Delphi Method.
4. Explain in detail about software Maintenance.
5. Explain about CASE tools.