MA8391/PROBABILITY AND STATISTICS
UNIT 1
RANDOM VARIABLES
PART –A

1. A continuous random variable X has probability function $f(x)=\begin{cases}3x^2, 0\le x\le 1\\ 0, otherwise\end{cases}$,find k such that p(X>k)=0.5.

2. If X is uniformly distributed in $(\frac{-\pi}{2},\frac{\pi}{2})$.find the pdf of Y=tanX.

3. TheCDF of a continuous random variable is given by $F(x)=\begin{cases}0, x>0\\ 1-e^{-\frac{x}{5}}, 0\le x\le\infty\end{cases}$,find the PDF and mean of X.

4. Establish the memory less property of the exponential distribution.

5. Test whether $F(x)=\begin{cases}|x|, -1\le x\le 1\\ 0, otherwise\end{cases}$ can be the probability density function of a continuous random variable.

6. What do you mean by MGF? Why it is called so?

7. A continuous random variable x has the probability density function given by

$$F(x)=\begin{cases}a(1+x^2), 2\le x\le 5\\ 0, otherwise\end{cases}$$

Find a and P(X<4).

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8.FindC,if $p(X=n)=C\left(\frac{2}{3}\right)^n : n=1,2,...$

9. If the probability that a target is destroyed on any7 one shot is 0.5 find the probability that it would be
Destroyed on 6th attempt.

10.Define random variable.

11. Define geometric distribution.

12.A random variable X has cdf $F(x)=\begin{cases}0, x<1\\ \frac{1}{2}(x-1), 1\le x\le 3\\ 1, x\ge 3\end{cases}$ find the pdf of X and the expected value of x.

13. Find the moment generating function of binomial distribution.

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14. Find c if a continuous random variable X has the density function $f(x)=\left\{\frac{c}{1+x^2}\right.$, -∞<x<∞.

15. Find the moment generating function of Poisson distribution.

16.X and Y are independent random variables with variance 2 and 3 .find the variance of 3x+4Y.

17. Show that the function $f(x) = \begin{cases} e^{-x}, x \geq 0 \\ 0, x < 0 \end{cases}$ is a probability density function of a random variable X.

PART –B

01. The probability mass function of random variable X is defined as $P(X=0)=3C^2$, $P(X=1)=4C-10C^2$, $P(X=2)=5C-1$, where $C>0$ and $P(X=r)=0$ if $r \neq 0,1,2$. Find

(i) The value of C.

The distribution function of X

(ii) The largest value of X for which $F(X)<\frac{1}{2}$

$P(0<X<2/X>0)$

02. The probability density of the random variable X is given by

$$f_X(x)=\begin{cases} x, & 0<x<1 \\ k(2-x), & 1 \leq x \leq 2 \\ 0, & otherwise \end{cases}$$. Find

(i) The value of 'k'

The distribution function of $f(x)$

(ii) $P(0.2<x<1.2)$

$P(0.5<x<1.5/x \geq 1)$

The probability function of an infinite discrete distribution is given by

$P(X=j)=\frac{1}{2^j}, j=1,2,3,\ldots$ Find

(i) Mean of **X**

(ii) P(**X is even**) and

(iii) P(**X is divisible by 3**)

03. A continuous random variable X has the PDF $f(x)=\begin{cases} \frac{k}{1+x^2}, & -\infty<x<\infty \\ 0, & otherwise \end{cases}$. Find

(i) The value of 'k'

(ii) Distribution function of X

(iii) $P(X \geq 0)$

04. Show that the probability function $P[X=x]=\begin{cases} \frac{1}{x(x+1)}, & x=1,2,3,\ldots \\ 0, & otherwise \end{cases}$ $E[X]$ does not exist.

05. A random variable X has the following probability distribution.

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

Find

(i) The value of k.

06. $P(1.5 < X < 4.5 \mid X > 2)$, and
The smallest value of λ for which $P(X \le \lambda), > \frac{1}{2}$.

If X and Y are independent RVs each normally distributed with mean zero and variance σ^2,find the pdf of $R = \sqrt{x^2 + y^2}$ and $\phi = \tan^{-1}(\frac{y}{x})$.

07. A continuous random variable X that can assume any value between X=2 and X=5 has a probability density function f(x)=k(1+x).FindP(X<4).

08. If the probability mass function of a random variable X is given by P(X=x)=kx3,x=1,2,3,4,find the value of k,P((1/2<X<5/2)/X<1),mean and variance of X

09. A car hire firm has 2 cars.The number of demands for a car on each day is distributed as poisson variate with mean 0.5.Caluculate the proportion of days on which (1) neither car is used (2)some demand is refused.

PROBLEM RELATED TO MOMENTS

01. A continuous random variable has PDF $f(x) = Kx^2 e^{-x}, \quad x \ge 0$. Find K, rth moment, mean, and variance.

02. If the probability density of X is given by $f(x) = \begin{cases} 2(1-x), & 0 < x < 1 \\ 0, & otherwise \end{cases}$. Find its rth moment. Hence evaluate $E\left[(2X+1)^2\right]$.

03. A random variable X has the pdf $f(x) = \begin{cases} 2e^{-2x}, x \ge 0 \\ 0, x < 0 \end{cases}$ obtain the mgf and first four moments about the origin.Find the mean and variance of the same.

04. Find the MGF of a random variable X having the pdf $f(x) = \begin{cases} \dfrac{x}{4e^{\frac{x}{2}}}, x \ge 0 \\ 0, elsewhere \end{cases}$.Also deduse the first four moments about the origin.

PROBLEM RELATED TO MGF

01. Find MGF corresponding to the distribution $f(\theta)=\begin{cases}\frac{1}{2}e^{-\theta/2}, & \theta>0\\ 0, & \theta<0\end{cases}$ and hence find its mean and variance.

02. Find the MGF of the random variable X having the PDF $f(x)=\begin{cases}\frac{x}{4}e^{-\frac{x}{2}}, & x>0\\ 0, & x<0\end{cases}$. Also deduce that first 4 moments about the origin.

03. Find the nth moment about mean of normal distribution.

04. State and prove memoryless property of Geometric distribution.

PROBLEM RELATED TO BINOMIAL DISTRIBUTIONS

01. Find moment generating function of the Binomial distribution. Hence find its Mean and Variance.

02.Describe binomial B(n,p) distribution & obtain the mgf.hence compute (i) first four moments and (ii)the recursion relation for the central moments.

03. A coin is biased so that a head is twice as likely to appear as a tall. If the coin is tossed 6 times, find the probabilities of getting (1) exactly 2 heads, (2) atleast 3 heads, (3) atmost 4 heads.

PROBLEM RELATED TO POISSON DISTRIBUTIONS

01. Find the MGF of a Poisson distribution and hence deduce its mean&variance.

02. Derive Poisson distribution from the binomial distribution

03. Suppose that a customer 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.(1)exactly 4 customers arrive and (2)more than 4 customers arrive.

04.An office has four phone lines .each is busy about 10% of the time.Assume that the phone lines act independently(1)what is the probability that all four phones are busy?(2)what is the probability that atleast two of them are busy?

05.The number of monthly breakdowns of a computer is a random variable having a poisson distribution with mean equal ti 1.8.Find the probability that this computer will function for a month

(1) without a braekdown (2)with only one breakdown.

PROBLEM RELATED TO GEOMETRIC DISTRIBUTIONS

01. 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 and
   (ii) In less than 4 trials.
02. Prove the memory less property of the geometric distribution.

PROBLEM RELATED TO UNIFORM DISTRIBUTIONS

01. Find the MGF and hence the mean and variance of the uniform distribution.

02. A random variable X is uniformly distributed over (0,10).find (1)p(X<3),P(X>7)and P(X<5)(2)P(X=7).

03.A random variable Y is defined as $cosn\pi$,where X has a uniform probability density function over $\left(-\frac{1}{2},\frac{1}{2}\right)$.Find the mean and S.D

PROBLEM RELATED TO EXPONENTIAL DISTRIBUTIONS

01. Find the MGF of the two parameter exponential distribution whose density function is given by $f(x)=\lambda e^{-\lambda(x-a)}, x\geq a$ and hence find the mean and variance.
02. The time in hours required to repair a machine is exponentially distributed with parameter $\lambda=1/2$.
   (i) What is the probability that the repair time exceeds 2 hours?
   (ii) What is the conditional probability that a repair takes atleast 10 hours given that its duration exceeds 9 hours?

PROBLEM RELATED TO GAMMA DISTRIBUTIONS

01. Define Gamma distribution and find its mean and variance of the same.
02. The daily consumption of milk in excess of 20,000 liters is approximately distributed as gamma random variable with parameter $k=2, \quad \lambda=\frac{1}{10,000}$. If the city has a daily stock of 30,000 liters on a given day, find the probability that the stock is insufficient.

03. Find moment generating function of the Gamma distribution. Hence find its Mean and Variance.

04. Define the mgf of a random variable? Derive the mgf,mean,variance and the first four moments of a gamma distribution.

05. In a certain city, the daily consumption of electric power in millions of Kilowatt – hours can be considered as a random variable following gamma distribution with parameters $\lambda = \frac{1}{2}$ and $\alpha = 3$. If the power plant in this city has a daily capacity of 12 million Kilowatt hours, what is the probability that this supply of power will be insufficient on any given day?

PROBLEM RELATED TO NORMAL DISTRIBUTIONS

01. Assume that the radiation of a person's oxygen consumption during a period of Transcendental Meditation (T.M) is a continuous random variable X normally distributed with mean 37.6 cc/min and S.D 4.6 cc/min. determine the probability that during a period of T.M a person's oxygen consumption will be reduced by
    (i) At least 44.5 cc/min
    (ii) At most 35.0 cc/min
    (iii) Anywhere from 30.0 to 40.0 cc/min.
02. Given that X is distributed normally, if $P[X < 45] = 0.31$ and $P[X > 64] = 0.08$ find the mean and standard deviation of the distribution.
03. If $\boldsymbol{X}$ and $\boldsymbol{Y}$ are independent random variables following $N(8, 2)$ and $N(12, 4\sqrt{3}$ respectively, find the value of λ such that $P[2X - Y \leq 2\lambda] = P[X + 2Y \geq \lambda]$.
04. The marks obtained by a number of students in a certain subject are assumed to be normally distributed with mean 65 and standard deviation 5. If 3 students are selected at random from this group, what is the probability that two of them will have marks over 70?

05.Let X and Y be independent normal variates with mean 45 and 44 and standard deviation 2and 1.5
respectiively.what is the probability that randomly chosen values of X and Y differ by 1.5 or more?

06. In a normal distribution, 31% of items are under 45 and 8% of items are over 64. Find the mean
and standard deviation of the distribution.

07.In a test on 2000 electric bulbs,it was found that the life of a philips bulbs was normally distributed with an average of 2400 hours and S.D of 60 hours.Estimate the number of bulbs likely to burn for(i) more than 2150 hours,(ii) less than 1950 hours

05. 08.A manufacturer produces covers where weight is normal with mean $\mu = 1.950\ g\ and\ S.D.\ \sigma = 0.025\ g$. The covers are sold in lots of 1000.How many covers in a lot may be heavier than 2g?

UNIT 2

(TWO DIMENSIONAL RANDOM VARIABLES)

PART –A

1. Let X and Y be continuous random variable with joint probability density function $f_{xy}(x,y)=\frac{x(x-y)}{8}, 0<x<2, -x<y<x$

and $f_{xy}(x,y)=0$ elsewhere find $f_{\frac{y}{x}}(\frac{y}{x})$

2. State central limit theorem for two random variables.
3.Find the value of k,if f(x,y)=k(1-x)(1-y) in 0<x,y<1 and f(x ,y)=0 otherwise is to be the joint density function.

4. The joint probability density function of a two dimensional R.V (x,y) is given by $f(x,y)=k(6-x-y)$;
$0\le x\le 2;\ 2\le y\le 4$ Find K

5. If the point of (X,Y) is $f_{xy}(x,y)=\begin{cases} e^{-(x+y)}, x>0, y>0 \\ 0, otherwise \end{cases}$,check whether X and Y are independent.
6. The regression equations of X on Y and Y on X are respectively 5x-y = 22 and 64x-54y = 24.find the means
of X and Y.

7. Find the acute angle between the two lines of regression assuming the two lines off regression.

8. Find the marginal density function off X and Y if $f(x,y)=\begin{cases} \frac{6}{5}(x+y^2), 0\le x\le 1, 0\le y\le 1 \\ 0, otherwise \end{cases}$

9.Let X and Y be two discrete random variables with joint probability mass unction $P(X=x,Y=y)=\begin{cases} \frac{1}{18}(2x+y),, x=1,2 and y=1,2 \\ 0, otherwise \end{cases}$ .find the marginal probability mass function of X and Y.

10. The joint pdf of the random variables (x,y) is given by $f(x,y)=kxye^{-(x^2+y^2)}$,x>0,y>0.find the value of k

11. Comment on the statement:"ifCOV(X,Y)=0,then X and Y are uncorrelated".

12. The joint pmf of the random variables (x,y) is given by

$$p_{X,Y}(x,y)=\begin{cases} kxy, x=1,2,3: y=1,2,3 \\ 0, otherwise \end{cases}$$,find the value of k.

13. The joint pdf of the random variables (x,y) is given by $f_{xy}(x,y)=xy^2+\frac{x^2}{8}$,0≤x≤2,0≤y≤1.find P(X<y).

14. Define the joint pmf of a two dimensional discrete random variable.

15. State the basic properties of joint distribution of (x,y) when X and Y are random variables.

PART B

PROBLEM RELATED TO MDF&CDF

01. If X and Y are independent Poisson random variables with parameters λ_1 and λ_2. Calculate the conditional distribution of X, given that X + Y = n.

02. $f(x,y)=\begin{cases} x\,y^2+\frac{x^2}{8}, 0\le x\le 2, 0\le y\le 1 \\ 0, \quad otherwise \end{cases}$. Compute

$P\left(Y<\frac{1}{2}\right), P\left(X>1 | Y<\frac{1}{2}\right), P(X+Y\le 1),$

03. If the joint distribution function of X and Y is

$$F(x,y)=\begin{cases} 1-e^{-x}-e^{-y}+e^{-(x+y)} & : x>0,\ y>0 \\ 0 & : otherwise \end{cases},$$

Find

Marginal densities of X and Y.

$P(x\le 1, y\le 1)$

$P((x+y)\le 1)$

$P(x<1)$ and check whether X and Y are independent.

04. The joint PDF of the random variable (X, Y) is given by

$$f(x,y)=\begin{cases} k\,x\,y\,e^{-\left(x^2+y^2\right)} & : x>0, y>0. \\ 0 & : otherwise \end{cases}$$

Find

(i) Find k (ii)

Find $Cov(X,Y)$

(iii) Prove that X and Y are independent

05. The joint probability density function of the two dimensional RV is

$$f(x,y)=\begin{cases}\frac{8}{9}xy & :1<x<y<2\\ 0 & :otherwise\end{cases}.$$

(i) Find the marginal density functions of X and Y
(ii) Find the conditional density function of Y given X.

ROBLEM RELATED TO COVARIANCE

01.Find the covariance of X and Y, if the random variable has the joint PDF

$$f(x,y)=\begin{cases}x+y, & 0\le x,y\le 1\\ 0, & otherwise\end{cases}$$

02. The joint pdf of a random variable (X,Y) is $f(x,y)=25e^{-5y}, 0<x<0.2, y>0$. Find the covariance of X and Y.

03. Let (x,y) be a two dimensional non – negative continuous random variable having the joint density.

$f(x,y)=\begin{cases}4xye^{-(x^2+y^2)}, x\ge 0, y\ge 0\\ 0, Otherwise\end{cases}$, Find the density function of $U=\sqrt{x^2+y^2}$.

04. The join pdf of the random variable (X,Y) iff.$(x,y)=(x+y), 0\le x\le 1, 0\le y\le 1$, find cov(X,Y)

PROBLEM RELATED TO CORRELATION COEFFICIENT

01. The independent variables X and Y have the probability density functions given by

$f(x)=\begin{cases}4ax, & 0\le x\le 1\\ 0, & otherwise\end{cases}$ and $f(y)=\begin{cases}4ay, & 0\le y\le 1\\ 0, & otherwise\end{cases}$. Find the correlation coefficient between X + Y and X – Y.

02. The joint probability density function of the two dimensional random variable (X,Y) is

$f(x,y)=\begin{cases}2-x-y, & 0\le x,y\le 1\\ 0, & otherwise\end{cases}$. Find the correlation coefficient between X and Y.

03. Calculate the Correlation coefficient between height of father (x) and height of son (y)

65	66	67	67	69	68	70	72
67	68	65	68	72	72	69	71

If X and Y are uncorrelated random variables with variances 16 and 9. Find the correlation co efficient between X + Y and X – Y

PROBLEM RELATED TO REGRESSION

01. The regression equation of X on Y is 3Y – 5X + 108 = 0. If the mean value of Y is 44 and the variance of
the X is 9/16th of the variance Y. Find the mean value of X and the correlation coefficient.

02. In a partially destroyed laboratory record onlu the lines of regressions and variance of x are available. The regression equations are $8x-10y+66=0$ and $40x-18y=214$ and variance of $x=9$. Find

i. The correlation coefficient between x and y
ii. Mean values of x and y
iii. Variance of y.

PROBLEM RELATED TO TRANSFORMATION OF RANDOM VARIABLES

01. If X and Y are independent random variables with density function $f(x)=\begin{cases}1, 1\le x\le 2\\ 0, otherwise\end{cases}$

and $f(y)=\begin{cases}\frac{y}{6}, 2\le x\le 4\\ 0, otherwise\end{cases}$ find the density function of Z = XY.

02. If X and Y are independent random variables with probability density functions
$f(x)=4e^{-4x}, x\ge 0;\ f(y)=2e^{-2y}, y\ge 0;$ respectively

i. Find the density function of $U=\frac{X}{X+Y}$ and $V=X+Y$.

03.If the JPDF. of a RV (X, Y) is $f(x,y)=\begin{cases}x+y & :0\le x,\ 0\le y\\ 0 & :otherwise\end{cases}$. Find the density function of $U=X+Y$

PROBLEM RELATED TO CENTRAL LIMIT THEOREM

01. State and prove Central Limit Theorem.
02. A sample of size 100 is taken from a population whose mean is 60 and variance is 400. Using central limit theorem, with what probability can assert that the mean of the sample will not differ from $\mu = 60$ by more than 4.
03. The life time of particular verity of electric bulbs may be considered as a random variable with mean 1200 hours and standard deviation 250 hours. Using central limit theorem finds the probability that the average life time of 60 bulbs exceed 1250 hours.
$p[x\ge 1250]=0.0606$

04. If $V_i, i=1.2,...20$ are independent noise voltages received in an adder and V is the sum of voltage received, find the probability that the total incoming voltage V exceeds 105, using central limit theorem. Assume that each of the random variables V_i is uniformly distributed over (0, 10).

05. If $X_1, X_2, X_3, ...X_n$ are uniform variates with mean = 2.5 and variance = 3/4, use CLT to estimate $P[108\le S_n\le 126]$ where $S_n=X_1+X_2+X_3+.....+X_n$, $n=48$

06. Let $X_1, X_2, X_3, ...X_n$ be Poisson variates with parameter $\lambda=2$. Let
$S_n=X_1+X_2+X_3+.....+X_n$,
where $n=75$, find $P[120\le S_n\le 160]$ using CLT.

UNIT III
TESTING OF HYPOTHESIS
PART-A

1. Mention the various steps involved in testing of hypothesis. (OR) State the procedure followed in testing of hypothesis.
2. What are parameters and statistics in sampling?
3. Define Standard error.
4. Define Random sampling.
5. For the following cases, specify which probability distribution to use in a hypothesis test.

$$(i)\ H_0: \mu = 27, H_1: \mu \neq 27, \bar{x} = 20.1, \sigma = 5, n = 12$$

$$(ii)\ H_0: \mu = 98.6, H_1: \mu > 98.6, \bar{x} = 65, s = 12, n = 42$$

6. Define level of significance.
7. Define critical region.
8. Give two applications of χ^2 test.
9. For a 2 x 2 contingencytable

a	**b**
c	**d**

write the corresponding χ^2 value.

10. A Standard sample of 200 tins of coconut oil gave an average weight of 4.95 kgs with a standard deviation of 0.21 kg. Do we accept that the net weight is 5 kgs per tin at 5% level of significance?.
11. Define Type I and Type II error in the sampling distribution.
12. What are the expected frequencies of 2×2 contingency table

a	**b**
c	**d**

13. Write two applications of F-test
14. What are the uses of χ^2-distribution.
15. Write down the formula of test statistic t to find the significance of difference between the means of large samples.
16. Twenty people were attacked by a disease and only 18 survived. The hypothesis is set in such a way that the survival rate is 85% if attacked by this disease. Will you reject the hypothesis that it is more at 5% level $(z_{0.05} = 1.645)$?.
17. Define χ^2 test of goodness of fit. (OR) Write the formula for the χ^2 test of goodness of fit of a random sample to a hypothetical distribution.
18. Write the conditions for the application of χ^2 test.
19. Define level of significance.
20. It has been found that 2% of the tools produced by a certain machine are defective. What is the probability that in a shipment of 400 such tools
    (i) 3% more
    (ii) 2% or less will prove defective.
21. Define Null hypothesis and Alternative hypothesis.
22. What are the uses of χ^2-distribution.
23. Mention the uses and applications of t-distribution.
24. State two properties of F distribution.
25. Write two applications of F-test

PART-B

Large Sample Test – Z test (Single Sample)

1. A sample of 900 members has a mean 3.4 c.m and standard deviation 2.61 c.m. Is the sample from a large population of mean 3.25 c.ms and standard deviation of 2.61c.ms? (at 5% LOS).
2. The mean life time of a sample of 100 light bulbs produced by a company is computed to be 1570 hours with a standard deviation of 120 hours. If μ is the mean life time of all the

bulbs produced by the company, test the hypothesis $\mu = 1600$ hours, against the alternative hypothesis $\mu \neq 1600$ hours with 5% of LOS and 1 % LOS.

3. The mean breaking strength of the cables supplied by a manufacturer is 1800 with a S.D of 100. By a new technique in the manufacturing process, it is claimed that the breaking strength of the cable has increased. In order to test this claim , a sample of 50 cables is tested and it is found that the mean breaking strength is 1850. Can we support the claim at 1 % level of significance.

Large Sample Test – Z test (Two samples)

1. The means of two large samples of 1000 and 2000 members are 67.5 inches and 68.0 inches

respectively. Can the samples be regarded as drawn from the same population of standard

deviation 2.5 inches?

2. Random samples drawn from two countries give the following data relating to the heights

of adult males, Is the difference between Mean heights significant?

	Country A	Country B
Mean height (in inches)	67.42	67.25
S.D(in inches)	2.58	2.50
No.of samples	1000	1200

3. A sample of heights of 6,400 English men has a mean 67.85 inches and S.D 2.56 inches while a sample of heights of 1,600 Australians has a mean of 68.55 inches and a S.D 2.52 inches. Do the data indicate that Australians are on the average taller than Englishmen?
4. The average marks scored by 32 boys is 72 with a S.D of 8, while that of 36 girls is 70 with a S.D of 6.Test at 1% level of significance whether the boys perform better than girls.

Small Sample Test / t – Test (Single Sample)

1. A machinist is making engine parts with axle diameters of 0.7 inch. A random sample of 10 parts shows a mean diameter of 0.742 inch with S.D 0.04 inch. Compute the statistic you would use to test, whether the work is meeting the specification.
2. A certain injection administered to each of 12 patients resulted in the following increases of blood pressure : 5,2,8,-1,3,0,6,-2,1,5,0,4. Can it be concluded that the injection will be , in general, accompanied by an increase in B.P?

3. Sandal powder is packed into packets by a machine. A random sample of 12 packets is drawn and their weights are found to be 0.49,0.48,0.47,0.48,0.49,0.50, 0.51,0.49,0.48,
0.50,0.51,0.48. Test, if the average weight of the packing can be taken as 0.5 kg.

Small Sample Test / t – Test (Two samples)

1. The following are the average weekly losses of working hours due to accidents in 10 industrial plants before and after an introduction of a safety program was put into operation.

Before :	45	73	46	124	33	57	83	34	26	17
After :	36	60	44	119	35	51	77	29	24	11

Use to 0.05 level of significance to test whether the safety program is effective.

2. The following random samples are measurements of the heat production capacity (in millions of calories per ton) of specimen's of coals from two mine.

Mine 1 :	8,260	8130	8350	8070	8340
Mine 2 :	7950	7890	7900	8140	7920
	7840				

3. Two independent samples are chosen from two schools A and B , a common test is given in a subject . The scores of the students as follows:

School A :	76	68	70	43	94	68	33
School B :	40	48	92	85	70	76	68	22

4. A group of 10 rats fed on diet A and another group of 8 rats fed on diet B, recorded the following increase in weight(gms)
Diet A : 5, 6, 8, 1, 12, 4, 3, 9, 6, 10

Diet B : 2, 3, 6, 8, 10, 1, 2, 8

Does it show superiority of diet A over diet B.

5. Two horses A and B were tested according to the time (in seconds) to run a particular race with the following results:

Horse A :	28	30	32	33	33	29	34
Horse B :	29	30	30	24	27	29	

Test whether the horse A is running faster than B at 5% level.

Chi – Square Test (Goodness of fit)

1. The table below gives the number of aircraft accidents that occurred during the various days of the week .Test whether the accidents are uniformly distributed over the week

Days	Mon	Tue	Wed	Thu	Fri	Sat
No. of Accidents:	14	18	12	11	15	14

2. Four coins were tossed 160times and the following results were obtained:

No.of heads	0	1	2	3	4
Observed frequencies:	17	52	54	31	6

Under the assumption that the coins are unbiased, find the expected frequencies of getting 0, 1, 2, 3, 4 heads and test the goodness of fit.

3. Fit a Poisson distribution to the following data and test the goodness of fit

x :	0	1	2	3	4	5	6	7	8
y :	52	151	130	102	45	12	5	1	2

4.When the first proof of 392 pages of a book of 1200 pages were read,the distribution of printing mistakes were found to be as follows:

No.of mistakes (in a page):	0	1	2	3	4	5	6
No.of Pages	275	72	30	7	5	2	1

Fit a poisson distribution to the above data and test the goodness of fit.

5.A survey of 320 families with 5 children each revealed the following distribution:

No.of boys:	5	4	3	2	1	0
No.of girls:	0	1	2	3	4	5
No.of families:	14	56	110	88	40	12

Is this result consistent with the hypothesis that male and female births are equally probable?

Chi – Square Test (Independence of Attributes)

1. Find if there is any association between extravagance in fathers and extravagance in sons from the following data.

	Extravagant father	Miserly father
Extravagant son	327	741
Miserly son	545	234

1000 families were selected at random in a city to test the belief that high income families usually send their children to public schools and the low income families often send their children to government schools. The following results were obtained

Income	School		
	Public	Govt.	Total
Low	370	430	800
High	130	70	200
Total	500	500	1000

Test whether income and type of school are independent

2. 1000 students at college level were graded according to their I.Q and their economic conditions. What conclusion can you draw from the following data:

Economic conditions	I.Q level	
	High	Low
Rich	460	140
Poor	240	160

3. Two samples of polls of votes for 2 candidates A and B for a public office are taken, one from among residents of urban areas and the other from residents of rural areas. The results are given below: Examine whether the nature of the area is related to voting preference in this election.

Vote for Area	A	B	Total
Rural	620	380	1000
Urban	550	450	1000
Total	1170	830	2000

4. On the basis of information noted below, find out whether the new treatment is comparatively superior to the conventional one

.

	Favourable	Non – Favourable
Conventional	40	70
New	60	30

6. In an investigation of health and nutrition of two groups of children of different social status, the following results are got. Discuss the relation between the health and their social status

Social Status	Poor	Rich
Below normal	130	20
Normal	102	108
Above normal	24	96

F - Test (Difference of variances)

1. Test whether there is any significant different between the variance of population from which of the following samples are taken:

Sample-I	20	16	26	27	23	22	--
Sample-II	27	33	42	35	32	34	38

2. Two random samples give the following results

Sample	Size	Sample mean	Sum of squares of deviations from the mean
I	10	15	90
II	12	14	108

Test whether the samples could have come from the same normal population

UNIT-IV
DESIGN OF EXPERIMENTS
PART-A

1. What are basic principles in the design of Experiment?
2. What is a 2^2 factorial design and Explain?
3. What are the basic elements of an ANOVA table for one way classification?
4. What are the Basic designs of experiments.
5. What is the aim of the design of experiment?
6. Define completely randomized design.
7. What is ANOVA?
8. What are the uses of ANOVA?
9.Compare and contrast RBD and LSD.
10. Is 2×2 Latin square Design possible?. Why?.
11. What are the advantages of a completely Randomized Experimental design. Solution:
12. What do you understand by "Design of an experiment"?

The design of experiments may be defined as 'the logical construction of the experiment in which the degree of uncertainty with which the inference is drawn may be well defined.

13. Explain the situations in which randomized block design is considered an improvement over a completely randomized design.
14.State the advantages of a factorial Experiment over a simple experiment.
15. Write down the ANOVA table for one way classification.
16. Write the ANOVA table for Latin square.
17. Why a 2 x 2 Latin square is not possible? Explain.
18. Define Mean sum of squares(M.S.S).
19. Discuss the advantages of the two-way classification method over one-way classificationif any.
20. Write the basic steps in ANOVA.

PART-B
One – Way ANOVA [CRD]

1. The following are the number of mistakes made in 5 successive days by 4 technicians working for a photographic laboratory. Test at 1% LOS whether the difference among the four sample means can be attributed to chance.

Technician

I	II	III	IV
6	14	10	9
14	9	12	12

10	12	7	8
8	10	15	10
11	14	11	11

2. The following table shows the lives in hours of four brands of electric lamps.

Brand A	1610	1610	1650	1680	1700	1800		
B	1580	1640	1640	1700	1750			
C	1460	1550	1600	1620	1640	1660	1740	1820
D	1510	1520	1530	1570	1600	1680		

Perform an analysis of variance test the homogeneity of the mean lives of the four brands of Lamps.

3. Three different machines are used for a production. On the basis of the outputs, set up one- way ANOVA table and test whether the machines are equally effective.

Machine I	Machine II	Machine III
10	9	20
15	7	16
11	5	10
10	6	14

4. The accompanying data results from an experiment comparing the degree of soiling for fabric copolymerized with the three different mixtures of methacrcylic acid . Analysis is the given classification.

Mixture 1	0.56	1.12	0.90	1.07	0.94
Mixture 2	0.72	0.69	0.87	0.78	0.91
Mixture 3	0.62	1.08	1.07	0.99	0.93

5. Weekly sales in Rs. In small shops in 3 towns A,B,C are as follows. Can we conclude that the shops in the 3 towns have the same average sales?

A	620	600	740	800	
B	410	380	350		
C	920	870	1040	1030	1010

<u>Two Way ANOVA (Randomized Block design) - RBD</u>

1. Analyze the following RBD and find your conclusion.

Blocks	Treatments			
	T 1	T 2	T 3	T 4
B 1	12	14	20	22
B 2	17	27	19	15
B 3	15	14	17	12
B 4	18	16	22	12
B 5	19	15	20	14

2. An experiment was designed to study the performance of 4 different detergents for cleaning fuel injectors. The following “cleanliness” readings were obtained with specially designed equipment for 12 tanks of gas distributed over 3 different models of engines.

		Engine		
		I	II	III
Detergent	A	45	43	51
	B	47	46	52
	C	48	50	55
	D	42	37	49

3. Perform two – way ANOVA for the following data.

Plots of Land	Treatment			
	A	B	C	D
I	38	40	41	39
II	45	42	49	36
III	40	38	42	42

4. Consider the results given in the following table for an experiment involving six treatments in
fourrandomized blocks. The treatments are indicated by numbers within parenthesis.

Blocks	Yield for a randomized block experiment treatment and yield					
1	(1) 24.7	(3) 27.7	(2) 20.6	(4) 16.2	(5) 16.2	(6) 24.9
2	(3) 22.7	(2) 28.8	(1) 27.3	(4) 15.0	(6) 25.5	(5) 17.0
3	(6) 26.3	(4) 19.6	(1) 38.5	(3) 36.8	(2) 39.5	(5) 15.4
4	(5) 17.7	(2) 31.0	(1) 28.5	(4) 14.1	(3) 34.9	(6) 22.6

Test whether the treatments differ significantly.

5. Four varieties A, B, C and D of a fertilizer are tested in a Randomized block design with four replications.

The Plot yields in pounds are as follows

A(12)	D(20)	C(16)	B(10)
D(18)	A(14)	B(11)	C(14)
B(12)	C(15)	D(19)	A(13)
C(16)	B(11)	A(15)	D(20)

Analyze the experimental yield.

6. The sales of 4 salesmen in 3 seasons are tabulated here. Carry out an analysis of variance.

Seasons	Salesmen			
	A	B	C	D

Summer	36	36	21	35
Winter	28	29	31	32
Monsoon	26	28	29	29

Latin Square Design

1. Analyse the variance in the Latin square of yields (in kgs.) of paddy where P,Q,R,S denote the different method of cultivation:

S122	P121	R123	Q122
Q124	R123	P122	S125
P120	Q119	S120	R121
R122	S123	Q121	P122

Estimate whether different method of cultivation have significantly different yields.

2. The following is a Latin square of a design when 4 varieties of seeds are being tested .Set up the analysis of variance table and state your conclusion. You can carry out suitable change of origin and scale.

A 100	B 100	C 130	D 120
C 120	D 130	A 110	B 110
D 120	C 100	B 110	A 120
B 100	A 140	D 100	C 120

3. The following data represent the number of units of production per day turned out by 5 different workersusing 4 different types of machines.

Workers	Machine Type			
	A	B	C	D
1	44	38	47	36
2	46	40	52	43
3	34	36	44	32
4	43	38	46	33
5	38	42	49	39

(1) Test whether the mean production is the same for the different machine types.
(2) Test whether the 5 men differ with mean productivity.

4. The following is a Latin square of a design when 4 verities of seeds are being tested. Set up the analysis of variance table and state your conclusion. You can carry out suitable change of origin and scale.

A 105	B 95	C 125	D 115

C 115	D 125	A 105	B 105
D 115	C 95	B 105	A 115
B 95	A 135	D 95	C 115

5. Analyze the following Latin square experiment.

Column/Row	1	2	3	4
1	A(12)	D(20)	C(16)	B(10)
2	D(18)	A(14)	B(11)	C(14)
3	B(12)	C(15)	D(19)	A(13)
4	C(16)	B(11)	A(15)	D(20)

6. A farmer wishes to test the effect of 4 fertilizers A, B, C, D on the yield of wheat. The fertilizers are used in LSD and the results are tabulated here.Perform an analysis of variance.

A 18	C 21	D 25	B 11
D 22	B 12	A 15	C 19
B 15	A 20	C 23	D 24
C 22	D 21	B 10	A 17

7. A variable trial was conducted on wheat with 4 varieties in Latin square design.The plan of the experimentand per plot yield are given below:

C 25	B 23	A 20	D 20
A 19	D 19	C 21	B 18
B 19	A 14	D 17	C 20
D 17	C 20	B 21	A 15

Analyze the data.

UNIT-V
DESIGN OF EXPERIMENTS
PART-A

1. What are the charts we can use when the quality of a product is measurable quantitatively?
2. What are the three lines in control charts?
3. Write the formula for control chart value of a C-Chart and np-chart.
4. Write down the formula for Mean chart and R-chart.
5. What is Statistical quality control?
6. Define Acceptance Sampling.

7. What is range chart?
8. Define state of control.
9. Define np- chart.
10. Define c-chart.

PART-B

1. The following data relate to the number of defects in each of 15 units drawn randomly from a production process. Draw the control chart for the number of defects and comment on the state of control.

   6 4 9 10 11 12 20 109 10 15 10 2015 10.

2. A textile unit produces special cloths and packs them in rolls. The number of defects found in 20 rolls are given below.Estimate whether the process is under contol..

Defects in 20 rolls: 12,14,7,6,10,10,11,12,5,18,12,4,4,9,21,14,8,9,13,21.

3. The following table gives the sample means and ranges for 10 samples, each of size 6, in the production process of certain component. Construct the control charts for mean and range and comment on the nature of control.

Sample No.	1	2	3	4	5	6	7	8	9	10
Mean	37.3	49.8	51.5	59.2	54.7	34.7	51.4	61.4	70.7	75.3
Range	9.5	12.8	10.0	9.1	7.8	5.8	14.5	2.8	3.7	8.0

4. From the following table of means and range for 20 samples of five each, taken from inspection file draw mean and range chart.

X	1.79	1.8	1.76	1.81	1.85	1.75	1.83	1.77	1.71
R	0.39	0.08	0.35	0.14	0.28	0.23	0.26	0.19	0.21
X	1.57	1.74	1.81	1.68	1.82	1.69	1.78	1.72	1.55
R	0.47	0.23	0.29	0.10	0.36	0.22	0.3	0.32	0.23

5. Explain the charts that are used for attributes.

6. The table given below gives the measurements obtained in 10 samples. Construct control charts for mean and the range. Discuss the nature of control.[AP](8)

Sample No.	1	2	3	4	5	6	7	8	9	10
Measurements X	62	50	67	64	49	63	61	63	48	70
	68	58	70	62	98	75	71	72	79	52
	66	52	68	57	65	62	66	61	53	62
	68	58	56	62	64	58	69	53	61	50
	73	65	61	63	66	68	77	55	49	66
	68	66	66	74	64	55	53	57	56	75

7. The following data give the average life in hours and range in hours of 12 sample each of 15 lamps. Construct the control charts for $\bar{X}$ and R and comment on the state of control

$\bar{X}$	120	127	152	157	160	134	137	123	140	144	120	127
R	30	44	60	34	38	35	45	62	39	50	35	41

8. On inspection of 10 samples, each of size 400, the numbers of defective articles were
19 4 9 12 9 15 26 14 15 17

Draw the np chart and p chart and comment on the state of control.

VSB ENGINEERING COLLEGE, KARUR,
DEPARTMENT OF CHEMICAL ENGINEERING
Question Bank
CH8351: PROCESS CALCULATIONS

UNIT-I

PART-A

1. Caustic soda flakes obtained from a manufacturer are found to contain 60ppm silica. Convert this impurity into mass%.
2. A gas mixture 9.5% CO_2, 0.2% CO, 9.5% O_2 and 80.7% N_2 (by volume). Calculate its average molar mass..
3. Calculate the volume of 15kg of Chlorine at a pressure of 0.9bar and 293K assuming ideal gas law.
4. Define partial pressure.
5. What will be the % Na_2O content in lye containing 73% caustic soda?
6. It is necessary to store 1kg of methane at a temperature of 50oC and a pressure of 600atm. What is the volume of the vessel that must be provided?
7. Natural gas is piped from a well at 300K and 400MPa. The gas is found to contain by volume 93% methane and 4.5% ethane and the rest Nitrogen. Calculate the partial pressure of nitrogen.
8. Find the grams of HCl needed to prepare 1 litre of 2N HCl solution.
9. A sample of sea water contains 35000 ppm solids. Express the concentration of solids as mass%.
10. A 150 liter Oxygen Cylinder contains gas at 300K and 10bar pressure. What is the mass of oxygen in the cylinder?
11. An aqueous solution of common salt (NaCl) contains 25% salt (by mass) at 298.15K (25°C). Find the mole percent of NaCl in the solution?
12. Define normality and molality.
13. An aqueous solution of NaCl is prepared by dissolving 25kg of sodium chloride in 100kg of water. What is the mass fraction of NaCl and water?
14. Define partial pressure.
15. It is desired to compress 30kg of CO_2 to a volume of 5m3 at 30°C. Find the pressure of the gas stored (required)?
16. A gas mixture 9.5% CO_2, 0.2% CO, 9.6% O_2 and 80.7% N_2 (by volume). Calculate its average molar mass.
17. Calculate the volume of 15kg of chlorine at a pressure of 0.9 bar and 293K assuming ideal gas law.
18. Find the grams of HCl needed to prepare 1 litre of 2N HCl solution.
19. Explain Vanderwaal's equation of state:
20. State Dalton's law of partial pressures:
21. A mass of 100g each of HNO_3 H_2SO_4 is filled in two separate bottles. Which bottle contains more molecules? How many more?
22. A sample of caustic soda flakes contains 74.6% Na_2O (by mass). Find the purity of flakes.
23. An aquous solution contains 19% NH_3, 65.6% NH_4NO_3 and 6% Urea (by mass). Calculate

the available nitrogen content in the solution.

24. Make the following conversion: (a) 294g/L H_2SO_4 to normality.(b) 54.75g/L HCl to molarity.
25. Calculate the density of Chlorine gas at 503.15K (230°C) and 152 bar. a using ideal gas law.
26. Differentiate between wet and dry basis in the calculation of compositions.

PART-B

1. (i) Cracked gas from a petroleum refinery has the following composition by volume: Methane 45%, Ethane 10%, Ethylene 25%, propane 7%, propylene 8% and n-butane 5%. Find the average molecular weight of the gas mixture, specific gravity and composition by weight %

(ii) A steel tank having a capacity of 25m3 holds CO2 at 30oC and 1.6 atm. Calculate the mass in grams of CO2.

2.(i)A solution of caustic soda contains 20% NaOH by mass. Taking density of solution as 1.196kg/L. Find the normality, molarity and molality of the solution.

(ii)1 kmol of a mixture containing 0.4kmol of N2 and 0.6kmol of C2H6 occupying a volume of 90L at 323K(50oC). What is the pressure in the vessel? Use the Vander Waal's equation.

C2H6	Tc = 305.42K	Pc = 4.880MPa
N2	Tc = 126.09K	Pc = 3.394MPa.

3.(i) Calculate the total pressure and the composition of the vapor in contact with a solution at 100°C containing 35% benzene, 40% toluene and 25% Xylene. At 100°C the vapour pressure are 1340, 560 and 210 mm Hg respectively. (All compositions are in weight percent).

(ii) Calculate the available nitrogen content of a solution having 30% urea (NH_2CONH_2), 20% ammonium sulphate and 20% ammonium nitrate by mass

4.Carbureted water gas has the following composition by volume;
Hydrogen: 35.2%, methane: 14.8%, Ethylene: 12.8%, Carbon-di-oxide: 1.5%, carbon-monoxide: 33.9% and nitrogen: 1.8%. The gas is available at 773K and 0.4MPa. Find the molal volume of the mixture using ideal gas law and Vander Waal's equation.
Critical temperature in K of hydrogen, methane, ethylene, carbon-di-oxide, carbon-monoxide and nitrogen are 32.2, 190.5, 282.34, 304.12, 132.85 and 126.09.
Critical Pressure (in MPa) of hydrogen, methane, ethylene, carbon-di-oxide, carbon-monoxide and nitrogen are 1.297, 4.804, 5.039, 7.374, 3.494 and 3.394.

5.(i) The following is the analysis of a mixture of gases by mass:
Chlorine: 60%, Bromine: 25% and rest nitrogen. Calculate (i) composition by mole% (ii) Average molar mass (iii) Density at 298K and 740mm Hg
(ii) A steel tank having a capacity of 25m^3 holds CO_2 at 30°C and 1.6atm. Calculate the mass in grams of CO_2 .

6.(i)Calculate the volume of 1Kmol of steam (super heated) at 10Mpa pressure and 623K(350°C) temperature using (i) the ideal gas law and (ii) the Vander Waal's equation. If the actual volume is 0.4037m^3, analyze the percentage error by (i) and (ii). (Take P_c = 220.76 bar, T_c = 647.11K for water.)

(ii).Natural gas is piped from well at 300K and 400kPa. The gas is found to contain 93% methane and the rest nitrogen. Calculate the following (i) the partial pressure of nitrogen (ii) the pure component volume of methane in $10m^3$ of the gas. (iii) the density at standard conditions in kg/m^3.(iv) the density of gas as piped in kg/m^3.

7.(i)A solution of methanol in water containing 0.158 mole fraction of alcohol boils at 84.1^oC at a total pressure of 760 mm Hg. The resulting vapor contains 0.553 mole fraction of methanol. Vapor pressure of methanol at 80^oC and 100^oC is 1.764atm and 3.452atm respectively, How does the actual composition of the vapor compare with that calculated from Raoult's law?
(ii)An aqueous solution of K_2CO_3 contains 50% salt and the specific gravity of the solution is 1.53. Determine: (i) The mole percent of salt in the solution. (ii)The volume percent of water assuming the density of water as $1000kg/m^3$ and there is no volume change on mixing. (iii) The molality of the solution (iv) The molarity of the solution.

8. (i)Estimate the density of Chlorine gas at a temperature of 503K (230oC) and 15.2MPa Pressure using (i) ideal gas law (ii) Vander waal's equation. Take.
a= 0.6354(m3)2MPa/(kmol)2, b= 0.0543m3/kmol.
(ii) The value of ideal gas constant is 8.314J/gmol.K. How many gram moles of Nitrogen will occupy 1000m3 at a pressure of 112 X 103N/m2 at a temperature of 400K.

9.(i).A solution of NaCl in water contains 230g of NaCl per litre at 20^oC. The density of the solution at this temperature is 1.148g/cc. Find the composition in (i) mass % (ii) Volume percentage of water (iii) mole% (iv) g NaCl/ g water (v) molality.
(ii). The value of ideal gas constant is 8.314J/gmol.K. How many gram moles of Nitrogen will occupy 1000m3 at a pressure of 112 X 103N/m2 at a temperature of 400K.

10.(i) 20g of Caustic soda is dissolved in water to prepare 500ml of solution. Find the normality and molarity of the solution.
(ii) Compare the pressure given by ideal gas equation and Vander Waal's equation for I mole of gas occupying a volume of 381×10^5 m^3 at 40^oC. Given a = $0.3646N/m^2$ $mole^2$ and b = $4.28 \times 10^{-5} m^3/mole$.

UNIT-II

PART-A

1. What is purging and when does it become necessary?
2. Distinguish between conversion and yield.
3. The feed to a distillation column analyses by weight 28% benzene and 72% toluene. The distillate and bottom product analyses 52% benzene and 5% benzene by weight. Calculate the amount of distillate and bottom product per 1000kg of feed per hour.
4. Brief on recycle with a diagram.
5. What is meant by excess reactant and limiting reactant?
6. A wet substance weighing 100kg and containing 10% moisture content is dried to a final

product containing 5% moisture. Find the mass of the final dried product.

7. Wood containing 40% moisture is dried to 5% moisture by mass. What is the mass of water evaporated per kg of bone dry wood?

8. Write about limiting and excess reactants with suitable examples:

9. Represent bypass, recycle and purge in an industrial scheme:

10. Write the general equation of material balance:

11. State the degrees of freedom in the context of material balance for chemical processes.

12. A boiler feed water contains 2000ppm dissolved solids. The permissible limits of dissolved solids in the water in the boiler is 1 part per 100 parts. What percentage of feed water is to be blown down.

13. Give the difference between steady and unsteady processes:

14.In a process, two feed streams are there and one output stream. The feed streams have the feed rates as 500 kg/sec and 600 kg/sec. If the output stream rate is 800 kg/s, what is the mass stored in the chamber in five seconds?

15. In the given tank, there are two feeds and one output. Consider a 2 hour operation; the feed rates are 4000 kg/hr and 6000 kg/hr. The accumulated material inside the tank is 2000 kg. What is the output rate kg/hr of the material?

16.In a process, CO2 and water is given as feed and the mass fraction is 0.25 and 0.75 respectively. The feed stream is 5 Kg/s and the product stream is 10 Kg/sec. What is the feed stream of CO2 in Kg/s?

17. In a process, two feed a(400kg) and b(400 kg) is given. If the conversion is 50% and a & b converts in equal proportion, what is the weight of the product formed?

18.In a steady-state reactive system, 10 molar CH4 and 10 molar O2 are supplied to the system, what is the amount of CO2 produced?

19.In a distillation column for a feed of1000 kg the output is 80% of the feed and remaining 20% is waste. The feed contains 20% of Acetone and rest Water. The product contains 20% of Acetone and 40% of Water.How much Acetone is there in waste?

20. A batch of 20% of Acetic acid is prepared by mixing the Acetic acid of two containers A and B. A (400 kg) contains 80% of Acetic acidand B contains 15% of Acetic acid.How much kg of acid is prepared?

21. An aqueous solution with NaOH 10 g/L at the rate is 100 L/min and an organic compound with no NaOH at the rate 50 L/min were put into an extraction machine and produced aqueous solution with NaOH 1 g/L, what is the amount of NaOH in organic compound after extraction?

22.To obtain a 100 Kg of 40 % N2 solution, how much nitrogen must be added to a 20% nitrogen solution?

23.For the given reaction $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$ If the reactants C_5H_{12} & O_2 are having 2 moles an 8 moles of initial feed respectively. Which is the excess reactant in the reaction?

24. How many grams of C2H6 are required to produce 88 grams of CO2 when it is burned in the excess of oxygen?

25. For a given reaction $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ Assume that the percentage conversion of the limiting reactant is 60% and the feed composition in mole percent is 50% C_2H_6, 40% Cl_2 and 10% N_2.What is the mole percent of C_2H_6 in the product?

PART-B

1..(i)A single effect evaporator is fed with 10,000kg/h of weak liquor containing 15% caustic by mass and is concentrated to get thick liquor containing 40% by mass caustic (NaOH). Calculate (a)kg/h of water evaporated and (b) kg/h of thick liquor obtained.

(ii)A sample of coal is found to contain 63% carbon and 24% ash on mass basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate the percentage of the original carbon unburnt in the refuse.

2.(i)A feed to a continuous fractionating column anlyses 28% benzene and 72% toluene by mass. The analysis of the distillate shows 52 mass% benzene and and 5 mass% benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000kg of feed per hour. Also calculate the percent recovery of benzene.

(ii) A triple effect evaporator is used to concentrate 1000kg of aqueous solution from a concentration of 20% solute to 80% solute. Assuming an equal amount of vaporization in each effect, Calculate the composition and weight of the solution entering the second and third effects.

3.Carbon monoxide and hydrogen reacts to give methanol:

$CO + 2H_2 \rightarrow CH_3OH$

The conversion of CO entering the reactor is only 20%. A feed stream consisting of 33% CO, 66.5% H_2 and 0.5% CH_4 is mixed with a recycle stream and sent to a reactor.

The methanol leaving the reactor is separated and the unconverted gases are recycled. To prevent the accumulation of CH4 and keep its concentration in the recycle stream at 3%, a portion of the recycled stream is blown off. For 100 moles of fresh feed, determine the following :(i)The moles of the recycle stream. (ii)The moles of purge stream (iii) The composition of the purge stream. (iv)The moles of methanol produced.

4.A tank contains 50 liter of a salt concentration of 2.5g/liter. Another salt solution enters the tank at a rate of 2.0liter/min at a salt concentration of 1g/liter. The contents are stirred well and the mixture leaves the tank at a rate of 2.5liters/min. Estimate: (i) the time at which the concentration in the tank will be 1.25g/liter and (ii) the contents in the tank will be 20 liter.

5.Monochloro acetic acid (MCA) is manufactured in a semi-batch reactor by the action of glacial acetic acid with chlorine gas at 373K (100oC) in the presence of PCl3 catalyst. MCA thus formed will further react with chlorine to form di-chloroacetic acid (DCA). To prevent the formation of DCA, excess acetic acid is used. A small scale unit, which produces 5000 kg/d MCA, requires 4536kg/d of Chlorine gas. Also, 263kg/d of DCA is separated in the crystallizer to get almost pure MCA product. Find the % Conversion, % yield of MCA and selectivity.

6.Refined sugar is converted to glucose and fructose according to:

$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

Sucrose glucose fructose

The conversion of sucrose in one pass through the reactor is found to be 71.7%. apart of the product leaving the reactor is recycled in such quantities that after mixing the recycle stream with the fresh feed, the combined concentration of glucose and fructose in the stream entering the reactor is 4%. For 100kg of the sucrose solution containing 25% sucrose and 75% water

charged to the reactor as fresh feed, calculate the following: (i) The recycle flow. (ii) The combined concentration of fructose and glucose in the recycle stream. (Apr-May 2017).

7.A tank contains 50 liter of a salt concentration of 2.5g/liter. Another salt solution enters the tank at a rate of 2.0litre/min at a salt concentration of 1g/liter. The contents are stirred well and the mixture leaves the tank at a rate of 2.5liters/min. Estimate: (i) the time at which the concentration in the tank will be 1.25g/liter and (ii) the contents in the tank will be 20 liter.

8.An aqueous solution of Na_2CO_3 contains 15% carbonate by weight. 80% of the carbonate is recovered as $Na_2CO_3.10H_2O$ by evaporation of water and subsequent cooling to 278K. The solubility of Na_2CO_3 at 278K is 9.0% (weight). On the basis of 100kg of solution treated, determine the following: (a) the quantity of crystals formed. (b) the amount of water evaporated.

9.An aqueous solution of methanol containing 20% mass of methanol is to be separated into a distillate product containing 97% by mass of methanol and a bottom product containing 2% by mass of methanol. For treating 100kg of feed with a reflux ratio of 3.5 on a mass basis. Calculate (i) the amount of distillate and bottom products. (ii) the amount of vapour condensed in the condenser per kg of distillate. (iii) the amount of vapour condensed in the condenser per kg of feed.

10.(i).The ground nut seeds containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find the percentage recovery of oil.
(ii)A soap plant produces raw soap containing 50% moisture. This is to be dried to 20% moisture before it is pressed into cake for sale. How many 100g soap pieces can be obtained from 1000kg original raw soap?
(iii). The dilute acid containing 25% H_2SO_4 is concentrated by commercial grade sulphuric acid containing 98% H_2SO_4 to obtain desired acid containing 65% H_2SO_4. Find the quantities of the acids required to make 1000kg of desired acid.

UNIT-III

PART-A

1.What is relative humidity and percentage humidity?
2.Brief on percentage humidity.
3.Nitrogen gas is saturated with vapors of acetone at 295K and 105kPa. If the vapor pressure of acetone at 295K and 105kPa is 13.25kPa. Calculate the mole percent of acetone in the mixture.
4.Moist air contains 0.0109 kg water per cubic meter of the mixtures at 300K and 101.3kPa. Calculate the partial pressure of water vapor.
5.What is meant by wet bulb temperature and dry bulb temperature? How are they measured?
6. Define humid heat.
7. Define molal and absolute humidity.
8. Differentiate between bubble point and dew point with a diagram.
9. What is dew point? What will be the condition of humidity at dew point?

10. Relate absolute humidity and Molal humidity.
11. Define enthalpy of humid air.
12. What is adiabatic saturation temperature?
13. Define humid volume.
14.When the partial pressure of the vapour in the gas is same as the vapour pressure of the substance. What is the relative saturation?
15. What do you mean by Zero percent relative.
16. If the specific heats of a gas and a vapor are 0.2 kJ/kg. K and 1.5 kJ/Kg. K respectively and the humidity is 0.01, what is the humid heat in kJ/kg?
17.When the relative humidity of air goes up for the same temperature of air, what happens to the the dew point.
18. When the temperature increases, what about the relative humidity?
19**.** On a particular day the weather forecast states that the dry bulb temperature is 37° C, while the relative humidity is 50% and the barometric pressure is 101.325 kPa. Find the dew point temperature.
20. Moist air at 1 atm. pressure has a dry bulb temperature of 32° C and a wet bulb temperature of 26° C. Calculate a) the partial pressure of water vapour,
21. What happens to the saturation vapor pressure, when the air temperature increases?
22. Will an increase in dew point increases the relative humidity? Answer.
23. What will happen to the relative humidity when the air temperature increases while the dew point temperature stays the same.
24. Find the specific humidity, if the mass of water is 10 g and mass of bone dry air is 20 g?
25. Find the humid volume of the system at 100^oF with humidity 20%?

PART-B

1.The dry bulb temperature and dew point of ambient air were found to be 29^oC and 18^oC respectively. The barometer reads 100kPa. Compute: (i) the absolute molar humidity.(ii) the absolute humidity.(iii) the %RH.(iv) the % saturation.(v) the humid heat and (vi) the humid volume. The vapor pressure of water at dew point is 2.0624kPa and the vapor at saturation is 4.004kPa

2.An air water vapor sample at 101.3kPa has a dry bulb temperature of 328K and is 10% saturated with water vapor. Using the psychrometric chart determine the following: (a) The absolute humidity, kg water vapor per kg dry air. (b) The partial pressure of water vapor. (c) The absolute saturation humidity at 328K. (d) The vapor pressure of water at 328K. (e)The percentage relative saturation.(f) The dew point of the system.

3.An air-water vapor sample at 101.3kPa has a dry bulb temperature of 333K and an absolute humidity of 0.01kg water vapor per kg dry air. Using the psychrometric chart, determine the following: (a) The percent saturation.(b) The partial pressure of water vapor. (c) The absolute saturation humidity at 333K. (d)The vapor pressure of water at 333K. (e)The percent saturation. (f)The dew point of the system. (g) The humid heat. (h)The wet bulb temperature.

4.An adiabatic drier is used to dry a wet material. The drying air enters at 380.7K and 101.3kPa with a dew point of 298K. Measurements show that 2.25kg of water is evaporated per 100m3 of wet inlet air. Calculate using psychrometric chart (a) the humidity of air entering the drier.

(b) the exit air humidity and percent humidity. (c)the exit air wet bulb and dry bulb temperature. (d) the volume of exit air per 100m3 of inlet wet air.

5. The vapor pressure of acetone at 280K is 13.25kPa. For a mixture of nitrogen gas saturated with the vapors of acetone at 280K and 105kPa, Calculate the following: (a) The mole percent of acetone in the mixture. (b)The percent composition by weight. (c) The amount of vapors in kilograms per m^3 of the mixture.

6. A mixture of acetone vapor and nitrogen gas at 101.3kPa and 295K contains acetone vapor to the extent that it exerts a partial pressure of 15kPa. The vapor pressure of acetone at 295K is 26.36Pa. Determine the following: (a) The mole fraction of acetone in the mixture. (b) The weight fraction of acetone in the mixture. (c) the molal humidity (d) the absolute humidity (e) molal saturation humidity (f) the absolute saturation humidity. (g) the mass of acetone in $100m^3$ of the mixture.

7. A mixture of nitrogen and benzene has a dew point of 300K. the temperature and the pressure of the mixture are 335K and 150kPa respectively. The vapor pressure of benzene (kPa) at 300K is 13.811kPa and at 335K is 55.693kPa. Calculate the following: (a) Percent saturation of the mixture (b) Kilogram of benzene per kilogram of nitrogen. (c) Kilogram of benzene per m^3 of mixture. (d) dew point of the mixture if the total pressure is 100kPa. (e) Pressure required to condense 60% of the benzene from the mixture at 300K.

8. Ether at a temperature of 20oC exerts a vapor pressure of 442 mm Hg. Calculate the composition of a saturated mixture of nitrogen and ethyl ether vapor at 20^oC and 745mm Hg and express the same in the following forms: (a) Percentage composition by volume. (b) Composition by weight. (c)lb of vapor/ft^3 of mixture. (d) lb of vapor/lb of vapor free gas. (e) lb moles of vapor/ lb mole of vapor free gas.

9.(i) A mixture of acetone vapor and nitrogen contains 15% acetone by volume. Calculate Molal humidity, partial pressure of acetone, relative saturation and % saturation at 20^oC and 745 mm Hg. Vapor pressure of acetone at 20^oC = 184.8 mm Hg.
(ii). Air at 50% RH is to be used for a specific operation. Air is available at a DBT of 35^oC and 27^oC. What should be the final temperature to which it should be heated? It is found that a DBT of 30^oC will be quite comfortable for the labourers. How will you obtain this condition? Indicate the exact temperature to which it should be taken before bringing it to 30^oC and 50% RH. If it is necessary to use $5000m^3/h$ of air at the final condition mentioned above. Estimate the quantity of air needed at its original condition.

10. Air at 320K saturated with water vapor is humidified by cooling to 285K and by consequent condensation of water vapor. Air leaving the dehumidifier saturated at 285K is mixed with a part of the original air which is bypassed. The resulting air stream is reheated to 320K. It is desired that the final air contains water vapor not ,more than 0.03kg per kg of dry air. Calculate: (a) The mass of dry air (in kg) bypassed per each kg of dry air sent through the dehumidifier. (b) The mass of water vapor (in kg) condensed in the dehumidifier per $100m^3$ of air sent through it. (c) The volume of the final air obtained per $100m^3$ of air passed through the dehumidifier.

The total pressure is atmospheric and the vapor pressure of water are 1.4kPa at 285K and 10.6kPa at 320K.

Unit-IV
Part-A

1.How the heat capacity of solids is calculated using Kopp's rule?
2.Explain Hess's law.
3.What is heat of formation?
4.Define heat of combustion.
5.What is meant by the term "mean heat capacity of gases?
6.Calculate the heat that must be added to 3kmol air to heat it from 298K to 473K if the mean molal heat capacity of air is 29.3955kJ/kmol.K.
7.Define specific heat.
8.Distinguish between sensible and latent heat.
9.What is trouton's rule?
10.The standard heat of combustion of methane$_{(g)}$, carbon$_{(s)}$ and hydrogen$_{(g)}$ are -890.4kJ/mol, -393.51kJ/mol and -285.84kJ/mol respectively. Calculate the standard heat of formation of methane gas.
11.Determine the heat capacity of $Na_2SO_4.10H_2O$ at room temperature using Kopp's rule. The atomic heat capacity of elements (J/g.mole.K) are 26.04 for Na, 22.04 for S, 16.8 for O and 9.6 for H.
12.Define adiabatic reaction temperature.
13.Define theoretical flame temperature.
14.What is meant by Cox chart?
15.Calculate the standard heat of reaction of the given reaction.

$$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(s)} + 6H_2O_{(g)}$$

Data:

Component	ΔH_f^o, kJ/mol at 298.15K
$NH_{3(g)}$	-45.94
$NO_{(g)}$	90.25
$H_2O_{(g)}$	-241.82

16.The heat absorbed when $Na_2CO_3.10H_2O$ is dissolved isothermally at 291.15K (18°C) in a large quantity of water is 67.91kJ/mole solute. Calculate the heat of crystallization of 1kg $Na_2CO_3.10H_2O$.
17.Calculate the enthalpy of sublimation of iodine from the following reactions and data:

(a) $H_{2(g)} + I_{2(s)} \rightarrow 2HI_{(g)}$ $\Delta H = 57.9kJ$
(b) $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ $\Delta H = 9.2kJ$

The desired reaction is $I_2(s) \rightarrow I_2(g)$

18.Find the enthalpy of formation of liquid ethanol from the following data:

$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ $\Delta H = 1367.8kJ$
$C_{graphite} + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H = -393.5kJ$
$H_{2(g)} + 1/2O_{2(g)} \rightarrow H_2O_{(l)}$ $\Delta H = -285.8kJ$

19.Calculate the standard heat of reaction

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

Component	ΔH_f Cal/mol
CaC_2	-15,000
H_2O	-68317.4
$Ca(OH)_2$	-235800
C_2H_2	54194

20.How much heat must be added to raise the temperature of 1kg of a 20% Caustic solution from 7^oC to 87^oC? Take datum temperature as 0^oC.
Specific heat at 7^oC = 3.56 and at 87^oC = 3.76kJ/kg.K.

21.How many Joules are needed to heat 60kg of Sulphur tri oxide from 273.16K to 373.16K?

$$C_{pso3} = 34.38 + 42.86 \times 10^{-3}T - 13.21 \times 10^{-6}T^2 \text{ J/kmol.K.}$$

22.From the following reaction, estimate the heat of reaction at 298K.

$$A + B \rightarrow C + D$$

Compound	ΔH_f^o (kcal/g.mole)
A	-269.8
B	-195.2
C	-337.3
D	-29.05

23. Estimate the standard heat of reaction ΔH_{298}^o for the reaction $A + B \rightarrow C$
Standard heats of combustion are: $\Delta H_{c,298}$ for A = -328000 cal/g
$\Delta H_{c,298}$ for B = -21,2000 cal/g
$\Delta H_{c,298}$ for C = -54,2000 cal/g.

24.Calculate enthalpy change for one mole of a gas when it is heated from 400K to 1500K at 1atm pressure given that the mean specific heat of the gas at the reference temperature of 273K are 35kJ/kmol.K at 400K and 50kJ/kmol.K at 1500K.

25.Write the Clapeyron equation for estimating enthalpy of vaporization.

Part-B

1.(i). Toluene is to be heated from 290K to 350K at the rate of 250g/s. calculate the heat to be supplied to toluene using the heat capacity data given below:

$$C_p = a+bT+cT^2+dT^3 \text{ kJ/kmol.K}$$

Component	a	b	c	d
Toluene	1.80836	812.223×10^{-3}.	1512.67×10^{-6}	1610.01×10^{-9}

(ii) Calculate the heat of formation of liquid 1-3 butadiene at 298.15K using the following data:
Data:
Standard heat of formation of CO_2 = -393.51 kJ/mol.
Standard heat of formation of H_2O = -281.83 kJ/mol.
Heat of combustion of $C_4H_{6(l)}$ at 298K = -2530.11 kJ/mol.

2.Combustion of solid wastes produces a flue gas of the following analysis: CO2 = 9.0%, CO = 2.00%, O2 = 7.00% and N2 = 82.00%. Find the difference in enthalpies for this gas between the bottom and top of the stack. If the temperature of the gas at the bottom is 600K and that at the top is 375K. the heat capacities of the gas are:

CO: $C_p = 26.586 + 7.582*10^{-3}T - 1.12*10^{-4}T^2$
CO_2 : $C_p = 26.540 + 42.454*10^{-3}T - 14.298*10^{-4}T^2$
O_2 : $C_p = 25.74 + 12.987*10^{-3}T - 3.864*10^{-4}T^2$

N_2 : $C_p = 27.03 + 5.815*10^{-3}T - 0.289*10^{-4}T^2$
Cp is in KJ/Kmol.K and T is in K.

3.Calculate the heat required to raise the temperature of 28kg of CO from 100°C to 1000°C. Perform the calculations in the following ways: (1) Integrate the expression for C_p and (2) by using the mean heat capacity value for CO is given by the expression $C_p = 6.35 + 1.811*10^{-3}T - 0.267*10^{-6}T$, where Cp is in Kcal/K mole.K and T is in K.

4.A natural gas has the following composition on mole basis: CH4 = 84%, C2H6 =13% and N2= 3%. Calculate the heat to be added to heat 10Kmol of natural gas from 298K (25oC) using heat capacity data given below:

$Cp = a + bT + cT^2 + dT^3$ in KJ/Kmol.K

Gas	**a**	**b*10^3**	**c*10^6**	**d*10^9**
CH_4	19.2494	52.1135	11.973	-11.3173
C_2H_6	-5.4129	178.0872	-67.3749	8.7147
N_2	29.5909	-5.141	13.1829	-4.968

5.Calculate the enthalpy change in J/Kmol that takes place in raising the temperature of 1Kmol of the gas mixture of 80mol% methane and rest ethane from 323K to 873K. Heat capacity equation: $Cp(cal/gmol) = R(A + BT + CT^2)$.
R-Gas constant, T in Kelvin. A,B,C are constants.

Component	A	B*10^3	C*10^6
CH_4	1.702	9.081	-2.164
C_2H_6	1.131	19.225	-5.561

6.A gas mixture contains species A (MW=30) 15%, species B (MW = 45) 45% and species C (Mw = 80) 40% by weight. Calculate the quantity of heat necessary to heat one Kilomole of the mixture from 300K to 2700K. The constants of the molar heat capacity equation $Cp = a + bT + cT^2$ are as follows: where C_p is in KJ/Kmol.K and T is in K.

Species	**a**	**b**	**c*10^3**
A	25	0.05	-0.01
B	30	0.009	-0.05
C	21	0.08	-0.001

7.Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction.

$$CO_2 (g) + 2H_2 (g) \rightarrow CH_3OH (g)$$

Data:
$\Delta H^o_R = -90.41$ kJ/mol.
$C^o_p = a + bT + cT^2 + dT^3$ in kJ/kmol.K

Gas	**a**	**b X 10^3**	**c X 10^6**	**d X 10^9**
CO(g)	29.0277	-2.8165	11.6437	-4.7063
H_2(g)	28.6105	1.0194	-0.1476	0.769
CH_3OH(g)	21.137	70.843	23.86	-28.497

8.Consider the following reaction: $CO (g) + ½ O_2(g) \rightarrow CO_2(g)$
Find the heat of reaction at 100^oC. Standard heat of formation of CO (g) and $CO_2(g)$ are given as -26.4157 and -94.0518 kCal/mol respectively.
C_p for $O_2(g) = 6.117 + 3.167 \times 10^{-3} T – 1.005 \times 10^{-6} T^2$
C_p for $CO_2(g) = 6.339 + 10.01 \times 10^{-3} T - 3.415 \times 10^{-6} T^2$
C_p = for CO (g) = $6.350 + 1.811 \times 10^{-3} T – 0.2675 \times 10^{-6} T^2$
Here C_p is in cal/mol.K and T is in K.

9.Carbon monoxide at 473K is burned at a rate of 1 Kmol/h in a furnace using 100% excess air at 373K. the combustion is complete the gases leave at 1273K. Calculate the heat removed in the furnace. The mean heat capacity values in kJ/kmol.K in the temperature range of 298K to 1273K are 49.91, 33.25, 31.43, 29.29, and 29.38 for CO_2, O_2, N_2, air and CO respectively. The standard heat of combustion of CO at 298K is -282.00 kJ/mol.

10.A gas mixture consisting of 20% ethane and 80% Oxygen at 298K is burned completely after diluting it with double the volume of CO_2 also at 298K. The mean heat capacities in J/mol.K are 54.56 for CO_2, 43.02 for water vapour and 35.52 for oxygen. The standard heat of reaction is -1428kJ/mol of ethane at 298K. Determine the theoretical flame temperature.

11. A gas containing 20% CO and 80% N_2 is burnt with 100% excess air. Both air and gas initially being at 25^oC. A flame temperature of 942^oC is attained during combustion. Calculate the enthalpy of the products. Given mean molar heat capacities between 25^oC and 942^oC as CO_2 = -11.74,O_2 = -7.9 and N_2 = -7.45 cal/gmole.K.

Unit-V
Part-A

1.Classify fuels with examples.
2.If methane gas is burnt with the theoretical amount of air. Determine the percentage composition by volume of the flue gases obtained.
3.The gross calorific value of gaseous n-propanol (C_3H_7OH) at 298K is 2067.44kJ/mol. Find the net calorific value. Latent heat of water-vapor at 298K = 2442.5kJ/h.
4.What is orsat analysis?
5.What are proximate and ultimate analysis of coal?
6.Differentiate complete and incomplete combustion.
7.Crude oil is found to contain 87.1% carbon, 12.5% hydrogen and 0.4% sulphur (by mass).
8.What do you mean by percent excess air?
9.Define calorific value.
10.Differentiate NCV & GCV.
11.Pure carbon is completely burnt in oxygen. The flue gas analysis is 70% CO_2, 20% CO and 10% O_2. Find the excess air used.
12.Why is the actual flame temperature lower than the adiabatic flame temperature?
13.What is the main drawback of supplying more excess air in the combustion of fuels?
14.What is the percentage (by weight) of Oxygen in atmospheric air?
15.In what way does the increase in moisture content of coal affect the calorific value?
16.Find the average molecular weight of a flue gas having the composition by volume as CO_2 = 25%, O_2 = 25% & N_2 = 50%.

17.Write the sequence of absorption in flue gas analysis by Orsat apparatus.
18.Find the mass of Oxygen required for the theoretical complete combustion of 1kg of carbon.
19.Find the amount of oxygen required in kmole for the stoichiometric combustion of 12kg of carbon.
20.Write the products of complete combustion reaction.
21.Write the chemical equations for the combustion of ethylene and acetylene.
22.Write the products of incomplete combustion reaction.
23.Write the balanced chemical equations for the combustion of ethane and methane.
24.Write the balanced chemical equations for the combustion of propane and butane.
25.Write the chemicals used for the absorption of CO_2 and CO in the orsat technique for analyzing flue gases.

Part-B

1.A fuel gas containing 88.2% C and 11.8% H_2 is burnt with 20% excess air. 95% of carbon is burnt to CO_2 and the rest to CO. All the hydrogen is converted to water. Determine the Orsat analysis of the flue gas (dry flue gas).

2.A sample from Godavari Colliery has the following Ultimate analysis: Carbon= 50.22%, hydrogen = 2.79%, sulphur = 0.37%, nitrogen = 2.05%, Ash = 19.53%, Oxygen = 18.04% and moisture = 7.00%. This coal is burnt with 100% excess air. Calculate (a) The theoretical oxygen requirement per unit mass of coal. (b) The theoretical dry air requirement per unit mass of fuel and (c) the wet and orsat analysis of flue gases when the coal is burnt with 100% excess air.

3.The Orsat analysis of the flue gases from a boiler gas chimney by volume is as given below: CO_2 = 11.4%, O_2 = 4.2% and N_2 = 84.4%. Assuming complete combustion (i) Calculate % excess air and (ii) find the C/H ratio of the fuel.

4.The Ultimate analysis of a residual fuel oil (RFO) sample is C = 88.4%, H = 9.4% and S = 2.2% (by weight). The residual fuel oil is used a fuel in a power generating boiler with 25% excess air. Calculate (i) the theoretical dry air requirement (ii) the actual dry air supplied and (iii) the Orsat analysis of the flue gas.

5.Find the Orsat of the burner gas when pure sulphur is burned with 20% excess air. Of the sulphur burned, 5% is converted to SO_3 and the rest SO_2.

6.The analysis of gas entering the converter in a contact H_2SO_4 plant is SO_2 : 4%, O2 : 13% and N_2 : 83%. The gas leaving the converter getting contains 0.45% SO_2 on SO_3 free basis. Calculate the % of SO_2 entering the converter getting converted to SO_3.

7.A gas containing 5% SO_2, 10% O_2 and the rest 85% N_2 entering a catalytic chamber where the leaving gases contain only 0.5% SO_2. Estimate the fractional conversion of SO_2 to SO_3 and also the composition of gases leaving catalytic chamber.

8.A coal containing 87% C and 7% unoxidized hydrogen is burnt in air. If 40% excess air is used: (i) Calculate kg of air per kg of coal burnt and (ii) Assuming complete combustion, calculate the orsat analysis of the flue gases by weight%.

9.A pure gaseous hydrocarbon is burnt with excess air. The orsat analysis of the flue gas: CO_2 : 10.2%, CO = 1%, O_2 = 8.4% and rest nitrogen. What is the atomic ratio of H to C in the fuel? Find the percentage excess oxygen supplied.

10.A fuel gas contains CO_2 = 2%, CO = 34%, H_2 = 41%, O_2 = 1%, C_2H_4 = 7%, CH_4 = 10% and rest N_2. It is burnt with 25% excess air. Assuming complete combustion, estimate the Orsat analysis of the leaving gases.

11.A furnace using hydrocarbon fuel oil has a orsat analysis as follows: CO_2 = 10.2%, O2 = 8.3%, N_2 = 81.5%. Find the following: (a) % excess air used. (b) the composition of fuel oil in weight%. (c) m^3 of air supplied/ kg of fuel.

CH8301FLUID MECHANICS FOR CHEMICAL ENGINEERS

QUESTION BANKUNIT I

PART- A

1. Definefluidandfluidmechanics.
2. Definerealandidealfluids.
3. Definemassdensityandspecificweight.
4. Distinctb/wstaticsandkinematics.
5. Defineviscosity.
6. Definespecificvolume.
7. Definespecificgravity.
8. Distinctb/wcapillarityandsurfacetension.
9. Calculatethespecificweight,densityandspecificgravityof1literliquidwhichweighs7N.
10. StateNewton'slawofviscosity.
11. Namethetypesoffluids.
12. Definecompressibility.
13. Definekinematicviscosity.
14. Findthekinematicviscosityofoilhavingdensity981kg/m^3.Theshearstressatapointinoilis0.245 2N/m^2andvelocitygradientatthatpointis0.2/sec.
15. Determinethespecificgravityofafluidhaving0.05poiseandkinematicviscosity0.035stokes.
16. Findouttheminimumsizeofglasstubethatcanbeusedtomeasurewaterlevelifthecapillaryriseisr estrictedto2mm.Considersurfacetensionofwaterincontactwithairas0.073575N/m.
17. Writedowntheexpressionforcapillaryfall.
18. Explainvapourpressureandcavitations.
19. Twohorizontalplatesareplaced1.25cmapart.Thespacebetweenthemisbeingfilledwithoilofvi scosity14poises.Calculatetheshearstressinoilifupperplateismovedwithavelocityof2.5m/s.
20. StatePascal'slaw.
21. Whatismeanbyabsoluteandgaugepressureandvacuumpressure?
22. DefineManometerandlistoutitstypes.
23. Writeshortnoteson'DifferentialManometers'.
24. Definecentreofpressureandtotalpressure.
25. Definebuoyancyandcentreofbuoyancy.

26. DefineMetacentre.
27. DefineHydrostaticPressure.
28. AdifferentialmanometerisconnectedatthetwopointsAandB.AtBpressureis9.81N/cm^2(abs).FindtheabsolutepressureatA.

PART –B

1. Calculatethecapillaryeffectinmillimetersaglasstubeof4mmdiameter,whenimmersedin(a)water(b)mercury.Thetemperatureoftheliquidis20^{o}Candthevaluesofthesurfacetensionofwaterandmercuryat20^{o}Cincontactwithairare0.073575and 0.51 N/mrespectively.Theangleofcontactforwateriszerothatformercury130^o.Takespecificweightofwateras9790N/m^3.
2. Ifthevelocityprofileofaliquidoveraplateisaparabolicwiththevertex202cmfromtheplate,wherethevelocityis120cm/sec.calculatethevelocitygradientsandshearstressatadistanceof0,10and 20cmfromtheplate,iftheviscosityofthefluidis8.5poise.
3. A15cmdiameterverticalcylinderrotatesconcentricallyinsideanothercylinderofdiameter15.10cm.bothcylindersare25cmhigh.Thespacebetweenthecylindersisfilledwithaliquidwhoseviscosityisunknown.Ifatorqueof12.0Nmisrequiredtorotatetheinnercylinderat100rpmdetermineetheviscosityofthefluid.
4. Thedynamicviscosityofoil,usedforlubricationbetweenashaftandsleeveis6poise.Theshaftisofdiameter0.4mandrotatesat190rpm.Calculatethepowerlostinthebearingforasleevelengthof90mm.thethicknessoftheoilfilmis1.5mm.
5. If the velocitydistribution overa plate isgiven by u=2/3y – y^{2}in which Uis the velocity inm/satadistanceymeterabovetheplate,determinetheshearstressaty=0andy= 0.15 m.
6. DerivePascal’slaw.
7. Deriveexpressionforcapillaryriseandfall.
8. Twolargeplanesurfacesare2.4cmapart.Thespacebetweenthegapisfilledwithglycerin.Whatforceisrequiredtodragathinplateofsize0.5mbetweentwolargeplanesurfacesataspeedof0.6m/sec.ifthethinplateis(i)inthemiddlegap(ii)thinplateis 0.8cmfromoneoftheplanesurfaces?Takedynamicviscosityoffluidis8.1poise.
9. Calculatethecapillaryriseinaglasstubeof2.5mmdiameterwhenimmersedverticallyin(a)water(b)mercury.Takesurfacetension=0.0725N/mforwaterand=0.52N/mformercuryincontactwithair.Thespecificgravityformercuryisgivenas13.6andangleofcontactofmercurywithglass=130°.
10. Thediametersofasmallpistonandalargepistonofalargepistonofahydraulicjackat3cmand10cmrespectively.Aforceof80Nisappliedonthesmallpiston.Findtheloadliftedbythelargepistonwhen:
    a. Thepistonsareatthesamelevel

b. Smallpistonin40cmabovethelargepiston.The

densityoftheliquidinthejackisgivenas1000kg/m^3.

11. AU-Tube manometerisusedtomeasurethepressure ofwaterinapipeline,whichisinexcessofatmosphericpressure.Therightlimbofthemanometerc ontainswaterandmercuryisintheleftlimb.Determinethepressureofwaterinthemainline,ifthedi fferenceinlevelofmercuryinthelimbs.Utubeis10cmandthefreesurfaceofmercury isinlevelwithoverthecentreof thepipe.Ifthepressureofwaterin pipelineis reducedto9810N/m^2,Calculatethenewdifferenceinthelevelofmercury.Sketchthe arrangementinbothcases.
12. Averticalsluicegateisusedtocoveranopeninginadam.Theopeningis2mwideand 1.2mhigh.Ontheupstreamofthegate,theliquidofsp.Gr1.45,liesuptoaheightof 1.5mabove thetopofthegate, whereason thedownstreamsidethewater isavailableuptoaheighttouchingthetopofthegate.Findtheresultantforceactingonthegateandp ositionofcentreofpressure.Findalsotheforceactinghorizontally atthe topofthegatewhichiscapableofopeningit.Assumethegateishingedatthebottom.

UNITII

PART–A

1. Whatarethetypesoffluidflows?
2. Differentiatesteadyandunsteadyflow?
3. Differentiateuniformandnon–uniformflow?
4. Differentiatelaminarandturbulentflow?
5. Differentiatecompressibleandincompressibleflow?
6. Differentiaterotationalandirrotationalflow?
7. Differentiateonedimensionalandtwodimensionalflow?
8. Differentiatelocalandconvectiveacceleration?
9. Definevelocitypotentialfunction?
10. Definestreamfunction?
11. Whatisequipotentialline?
12. Givetherelationbetweenstreamfunctionandvelocitypotentialfunction?
13. StateBernouillie’sequation.
14. GivetheEuler’sequationofmotion.
15. Writetheexpressionrateofflowthroughventurimeter.
16. Forwhatpurposeorificemeterisused?Defineit?
17. Definepitottubeandgiveitsworkingprinciple?
18. Statemomentumequationandimpulsemomentumequation?
19. Whatdoyoumeanbyvorticity?
20. Differentiateforcedandfreevertexflowswithexamples?

21. Writetheequationformotionforvertexflowandforcedvortexflow.
22. WhataretheassumptionsmadeinderivingBernoulli'sequationandstateitsapplications.
23. Writetheexpressionforrateofflowthroughventurimeter.

PART –B

1. Derivecontinuityequationfromprincipleofconservationofmass.
2. Thevelocitycomponentforatwodimensionalincompressibleflowaregivenbyu=3x–2yandv=-3y–2x.Showthatthevelocitypotentialexists.Determinethevelocitypotentialfunctionandstreamfunction.
3. WaterflowsthroughapipeAB1.2mdiameterat3m/sandthenpassesthroughapipeBC1.5mdiameter.AtC,thepipebranches.BranchCDis0.8mindiameterandcarriesone – third ofthe flow inAB. The flow velocityin branch CEis 2.5 m/s. findthe volumerateofflowinAB,thevelocityinCD,thevelocityinBCandthediameterofCE.
4. AfluidflowfieldisgivenbyV=x^2yi+y^2zj–(2xyz+yz^2)kprovethatitisacaseof possiblesteadyincompressibleflow.Calculatethevelocityandacceleration atthepoint(2, 1, 3).
5. Derivethecontinuityequationforathreedimensionalincompressibleflow.
6. DerivetheEuler'sequationofmotionanddeducethattoBernouillie'sequation.
7. Thewaterisflowingthroughataperpipeoflength100mhavingdiameters600mmattheupper and 300 mmatthelower end,at the rateof 50litres/s.the pipe has aslope of 1in30.Findthepressureatthelowerendifthepressureatthehigherlevelis19.62N/cm^2.
8. Anoilofsp.Gr.0.8isflowingthroughaventurimeterhavinginletdiameter20cmandthroatdiameter 10 cm. theoil mercury differenyial manometer showsareadingof25cm.Calculatethedischargeofoilthroughthehorizontalventurimeter,Take C_D=0.98.
9. 250litres/s ofwaterisflowinginapipehavingadiameterof 300mm.ofthepipeisbentby135^o,findthe magnitude anddirectionof the resultantforce onthe bend.The pressureofwaterflowingis39.24N/cm^2.
10. Averticalwallisof8mheight.Ajetofwateriscomingoutfromanozzlewithavelocityof20m/s.Thenozzleissituatedatadistanceof20mfromtheverticalwall.Findtheangleofprojectionofthenozzletothehorizontalsothatthejetofwaterjustclearsthetopofthewall.

UNITIII

PART – A

1. Whatdoyoumeanbyviscousflow?
2. WhatisHagenPoisuille'sformula?
3. DefineKineticenergycorrectionfactor?
4. Definemomentumcorrectionfactor?

5. Definehydraulicgradientline.
6. Definethemajorenergylossandminorenergyloss.
7. Definewaterhammerinpipes.
8. Defineincompressibleflow.
9. Writedowntheexamplesoflaminarflow/viscousflow.
10. Whatarethecharacteristicsoflaminarflow?
11. Writedownchezy'sformula.
12. Writedowntheformulaforfindingtheheadlossduetoentranceofpipeh_i?
13. Writedowntheformulaforefficiencyofpowertransmissionthroughpipes?
14. Giveanexpressionforlossofheadduetosuddenenlargementofthepipes.
15. Giveanexpressionformomentumintegralequationoftheboundarylayer?
16. Differentiatebetweensteadyflowanduniformflow.
17. Acrudeofoilofkinematicviscosityof0.4stokeisflowingthroughapipeofdiameter300mmatthe rateof300liters/sec.Findtheheadlostduetofrictionforalengthof50mofthepipe.
18. Findthetypeofflowofanoilofrelativedensity0.9anddynamicviscosity20poise,flowingthroug hapipeofdiameter20cmandgivingadischargeof10lps.
19. Giveanexpressionforcoefficientoffrictionintermsofshearstress.
20. Giveanexpressionforlossofheadduetosuddencontraction.
21. Giveanexpressionforlossofheadattheentranceofthepipes.
22. Deriveanexpressionfordropofpressureforagivenlengthofapipe.
23. DefineDarcyformula.
24. Whatarethefactorsinfluencingthefrictionallossinpipeflow.
25. Givetheformulaaveragevelocity.
26. Givetheformulaforvelocitydistribution.
27. Whatarethefactorstothedeterminedwhenviscousfluidflowsthroughthecircularpipe?

PART-B

1. Find the head lost due to friction ina pipe of diameter300 mm and length 50m, throughwhichwaterisflowingatavelocityof3m/susing(i)Darcyformula,(ii)Chezy'sformulaf orwhichC=60.
2. Anoilofsp.Gr0.9andviscosity0.06poiseisflowingthroughapipeofdiameter200mmattherateo f60litres/sec./findtheheadlostduetofrictionfora500mlengthofpipe.Findthepowerrequiredto maintainthisflow.
3. The rateofflowofwaterthroughahorizontalpipeis0.25m^3/s.Thediameterofthe pipe whichis200mmissuddenlyenlargedto400mm.Thepressureintensityinthesmalleris11.772N/ cm^2.Determine:(i)lossofheadduetosuddenenlargement,(ii)pressureintensityinthelargepipe,(iii)powerlostduetoenlargement.
4. Ahorizontalpipeline40mlongisconnectedtoawatertankatoneenddischargesfreelyintotheatm osphereattheotherend.Forthefirst25mofitslengthfromthetank,the

pipeis150mmdiameteranditsdiameterissuddenlyenlargedto300mm.Theheightofwaterleveli nthetankis8mabovethecentreofthepipe.Consideringalllossesofheadwhichoccur,determineth erateofflow.Takef=0.01forbothsectionsofthepipe.

5. Apipeline,300mmindiameterand3200mlongisusedtopumpup50kgpersecondofoil whose density is 950 kg/$m^3$and whosekinematic viscosityis 2.1 stokes. The centreofthepipelineattheupperendis40mabovethanthatatthelowerend.Thedischargeattheup perendisatmospheric.Findthepressureatthelowerendanddrawthehydraulicgradientandthetot alenergyline.
6. A siphonofdiameter200mmconnectstwo reservoirs having a difference in elevation of15m.Thetotallengthofthesiphonis600mmandthesummitis4mabovethewaterlevelintheupp erreservoir.Iftheseparationtakesplaceat2.8mofwaterabsolute,findthemaximumlengthofsiph onfromupperreservoirtothesummit.Takef=0.004andatmosphericpressure=10.3mofwater.
7. Thedifferenceinwatersurfacelevelsintwotanks,whichareconnectedbythreepipesinseriesofle ngths300m,170mand210mandofdiameters300mm,200mmand400mmrespectively,is12m. Determinetherateofflowofwaterifco–efficientoffrictionare0.005,0.0052and0.0048respectively,considering:(i)minorlossesalso(ii)neglectingminorlosses.
8. Amainpipeisdividedintotwoparallelpipeswhichagainformsonepipe.Thelengthanddiameterf orthefirstparallelpipeare2000mand1.0mrespectively,whilethelengthanddiameterof2ndparall elpipeare2000mand0.8m.Findtherateofflowineachparallelpipe,iftotalflowinthemainis3m^3/ s.Thecoefficientoffrictionforeachparallelpipeissameandequalto0.005.
9. Apipeofdiameter20cmandlength2000misconnectstworeservoirs,havingdifferenceofwaterl evelsas20m.determinethedischargethroughthepipe.

   Ifanadditionalpipeofdiameter20cmandlength1200misattachedtothelast1200mlengthofthee xistingpipe,findtheincreaseinthedischarge.Takef=0.015andneglectminorlosses.

10. Apipeline60cmdiameterbifurcatesataY-junctionintotwobranches40cmand30cmindiameter.Iftherateofflowinthemainpipeis1.5m^3/s andmeanvelocityofflowin30cmdiameterpipeis7.5m/s,determinetherateofflowinthe40cmdi ameterpipe.
11. Apipelineoflength2000misusedforpowertransmission.If110.3625kWpoweristobetransmitt edthroughthepipeinwhichwaterhavingapressureof490.5N/cm^2atinletisflowing.Findthedia meterofthepipeandefficiencyoftransmissionifthepressuredropoverthelengthofpipeis98.1N/ cm^2.Takef=0.0065.
12. Findthemaximumpowertransmittedbyajetofwaterdischargingfreelyoutofnozzlefittedtoapie =300mlong and100mm diameterwithco efficient offrictionas0.01.theavailableheadatthenozzleis90m.

UNITIV

PART – A

1. Defineboundarylayer.
2. Definemomentumthickness.
3. Whatdoyoumeanbydraglift?
4. Whatarethedifferentmethodsofpreventingtheseparationofboundarylayers?
5. DifferentiatebetweenLaminarboundaryandturbulentboundarylayer.
6. Definedisplacementthickness.
7. Defineboundarylayerthickness.
8. Defineenergythickness.
9. WritedowntheVonKarmanmomentumintegralequation.
10. Writedowntheboundaryconditionsforthevelocityprofiles.
11. Differentiatelocalco-efficientofdragandaverageco-efficientofdrag.
12. Whataretheconditionsforseparationofboundarylayer?
13. Drawadiagramfordragforceonaplateduetoboundarylayer.
14. WritedowntheapplicationsofVonKarmanmomentumintegralequation.
15. WhatdoyoumeanbyLaminarSub–layer?
16. StateBoundarylayertheory.
17. Writedownthevaluesofboundarylayerthicknessanddragco–efficientforBlasius'ssolution.
18. Writedownthevaluesofboundarylayerthicknessanddragco–efficientforvelocityprofileu/U=2(y/δ)–(y/δ)^2
19. Writedownthevaluesofboundarylayerthicknessanddragco–efficientforvelocityprofileu/U=2(y/δ)–2(y/δ)^3+(y/δ)^4
20. Writedownthevaluesofboundarylayerthicknessanddragco–efficientforvelocityprofileu/U=sin(πy/2δ).
21. Writedownthevaluesofboundarylayerthicknessanddragco–efficientforvelocityprofileu/U=3/2(y/δ)–1/2(y/δ)^3.

PART-B

1. Brieflyexplaintheboundarylayerdefinitions.
2. Findthedisplacementthickness,themomentumthicknessandenergythicknessforthevelocitydistributionintheboundarylayergivenbyu/U=y/δ, whereuis thevelocityatadistanceyfromtheplateandu=Uaty=δ,whereδ=boundarylayerthickness.Alsocalculatethevalueofδ*/θ.
3. Findthedisplacementthickness,themomentumthicknessandenergythicknessforthevelocitydistributionintheboundarylayergivenbyu/U=2(y/δ)–(y/δ)^2.
4. Forthevelocityprofileu/U=2(y/δ)–(y/δ)^2,findtghethicknessofboundarylayerattheendoftheplateandthedragforceononesideofaplate1mlongand0.8mwide

whenplacedinwaterflowingwithavelocityof150mm/sec.Calculatethevalueofco-efficientofdragalso.Takeμforwater=0.01poise.

5. Forthevelocityprofileforlaminarboundarylayeru/U=2(y/ δ)–(y/δ)^3+(y/δ)^{4}obtain anexpressionforboundarylayerthickness,shearstress,dragforceononesideoftheplateandco–efficientofdragintermofReynoldnumber.
6. Forthevelocityprofileforlaminarboundaryflowu/U=sin(πy/2δ).Obtainanexpressionforboundarylayerthickness,shearstress,dragforceononesideoftheplateandco–efficientofdragintermsofReynoldnumber.
7. Forthevelocityprofileforlaminarboundarylayeru/U=3/2(y/δ)–1/2(y/δ)^{3}findthe thicknessoftheboundarylayerandtheshearstress1.5mfromtheleadingedgeofaplate.Theplatei s2mlongand1.4mwideandisplacedinwaterwhichismovingwithavelocityof200mmper second. Find the totaldrag force ontheplateifμfor water =0.01poise.
8. Forthevelocityprofileforturbulentboundarylayeru/U=(y/δ)$^{1/7}$,obtainanexpression forboundarylayerthickness,shearstress,dragforceononesideoftheplateandco–efficientofdragintermsofReynoldsNumber.Giventhestress(ζ_o)forturbulentboundarylayeras

$$\zeta_o=0.0225\rho\ U^2(\mu/\ \rho\ Ug)^{1/4}.$$

9. Determinethethicknessoftheboundarylayeratthetrailingedgeofsmoothplateoflength4mandofthewidth1.5m,whentheplateismovingwithavelocityof4m/sinstationaryair.Takekinematicviscosityofairas1.5x10^{-5}m^2/s.
10. Forthefollowingvelocityprofiles,determinewhethertheflowhasoronthevergeofseparationor willattachwiththesurface:
    (i) u/U=3/2(y/δ)–1/2(y/δ)^3
    (ii) u/U=2(y/δ)^2–(y/ δ)^3
    (iii) u/U=-2 (y/δ) + (y/δ)^2

UNIT V

PART- A

1. Definedimensionalanalysis.
2. Whatarethefundamentaldimensions?
3. GivethedimensionsofAreaandVolume.
4. Derivethedimensionsofvelocity.
5. DefineModel.
6. Listouttheadvantagesofmodelanalysis.
7. Definesimilitude.
8. DefineScaleratio.
9. Definedynamicsimilarity.
10. Givethetypesofforcesinamovingfluid.
11. Definedimensionlessnumbers.

12. Definesurfacetension.
13. Definepressureforce.
14. DefineElasticforce.
15. Givethetypesofdimensionlessnumbers.
16. DefineReynold’snumber.
17. DefineFroude’snumber.
18. Givetheclassificationofmodels.
19. Whatisanundistortedmodel?
20. Whatiddistortedmodel?
21. Givetheadvantagesofdistortedmodels.
22. Listoutthetypesofmodellaws.
23. ListouttheapplicationofFroude’smodellaws.
24. DefineWeber’smodellaws.

PART-B

1. ExplainBuckingham’stheorem.
2. Theresistingforce(R) ofasupersonicflightcanbeconsideredasdependentuponlengthofaircraft(l),velocity(V),airviscosity‘μ’,airdensity‘ρ’,andbulkmodulusofair‘k’.Expressthefunctionalrelationshipbetweenthesevariablesandtheresistingforce.
3. Ashipis300mlongmovesinseawater, whosedensityis1030 kg/m^3. A1:100modelof thistobetestedinawindtunnel.Thevelocityofairinthewindtunnelaroundthemodelis30m/sandtheresistanceofthemodelis60N.Determinethevelocityofshipinseawaterandalsotheresistanceoftheshipinseawater.Thedensityofairisgivenas1.24kg/m^3.TaketheKinematicviscosityofseawaterandairas0.012stokesand0.018stokesrespectively.
4. A7.2mheightand15mlongspillwaydischarge94m^3/s,underaheadof2.0 m.Ifa1:9 Scalemodelofthisspillwayistobeconstructed,determinemodeldimensions,headoverspillwaymodelandthemodeldischarge.Ifmodelexperienceaforceof7500N(764.53Kgf),determineforceontheprototype.
5. Aquarterscaleturbinemodelistestedunderaheadof12m.Thefullscaleturbineistoworkunderaheadof30mandtorunat428rpm.FindNformodel.Ifmodeldevelops100kWanduses1100l/satthisspeed,whatpowerwillbeobtainedfromfullscaleturbineassumingitsnis3%betterthanthatofmodel.
6. Using Buckingham’s π theorem, show thatthe drag force $F_D=\rho L^2V^2\varphi(Re,M)$whichRe $=\rho LV/\mu$; $M=V/C$; ρ=fluid mass density;L =chord length: V= velocity of aircraft;μ=fluidviscosity;C=sonicvelocity=$\sqrt{K/\rho}$whereK=bulkmodulusofelasticity.
7. Theresistance ‘R’ experiencedby apartially,submerged bodydependsupon thevelocity‘V’,lengthofthebody‘l’, viscosityof fluid ‘μ’,densityofthefluid‘ρ’,andgravitationalacceleration‘g’;obtainexpressionforR.
8. DerivetherelationusingBuckingham’sπtheorem$F=\rho U^2D^2f(\mu/UD\rho),ND/U)$.

9. Statethereasonsforconstructiondistortedmodelofriversanddiscussthevarioustypesofdistortioninmodels.Whatarethemeritsanddemeritsofdistortedmodelsascomparedtoundistortedmodel?
10. Inanaeroplanemodelofsize1/10ofitsprototypethepressuredropis7.5kN/m^3.The modelistestedinwater.Findthecorrespondingpressuredropintheprototype.Takedensityofairis1.4kg/m^3,densityofwateris1000kg/m^3,viscosityofairis0.00018poiseandviscosityofwateris0.01poise.

CH -8301 FLUID MECHANICS FOR CHEMICAL ENGINEERS
TWO MARKQUESTIONS ANDANSWERS

1. Define fluid and fluidmechanics.

Fluid may be defined as a substance which is capable of flowing and deforms continuously under the application of constant application of shear force. It has no definite shape of its own, but confirms to the shape of the containing vessel.

Itisthebranchofscience,whichdealswiththebehaviorofthefluids(liquidsorgases)at rest as wellasin motion.

2. Define MassDensity.

Mass Densityor Densityis definedas ratio of mass of thefluid to its volume (V) or mass per unit volume. Densityofwater =1gm/cm^3or 1000 kg/ m^3.

$$\rho = \frac{\text{Mass of fluid}}{\text{Volume of fluid}}$$

3. Define SpecificWeight.

It is the ratio betweenweight of a fluid to its volume.

$$w = \frac{Weightof\ \ fluid}{Volumeof\ \ fluid} = \left(\frac{Massof\ \ fluid}{Volumeof\ \ fluid}\right) \times g = \rho \times g$$

$$\boxed{w = \rho \times g}$$ Unit: N / m^3

4. Define Viscosity.

Viscosityisdefinedastheproperty offluid,whichoffersresistancetothemovement of onelayer of fluidoveranotheradjacentlayer of fluid. Whentwolayersmoveoneovertheotherat differentvelocities,sayuandu+du,theviscositytogetherwithrelativevelocitycausesashearstressactingbetweenthefluidlayers.Thetoplayercausesa shearstressontheadjacentlowerlayerwhilethelowerlayercauses ashear stress on the adjacent top layer. This shearstress is proportional to the rate of change ofvelocity.

$$\boxed{\tau = \mu \frac{du}{dy}}$$

$\mu \Rightarrow$ Coefficient of dynamic viscosity(or) onlyviscosity
du / dy=rate ofshear strain

5. Define SpecificVolume.

Volume per unit mass ofafluid is called specific volume.

$$\text{sp.vol.} = \frac{\text{volume of fluid}}{\text{mass of fluid}}.$$

Unit: m^3/ kg

6. Define SpecificGravity.

Specificgravityistheratiooftheweightdensityordensityofafluidtotheweight densityor densityof standardfluid.It is also calledas relative density.

Unit : Dimensionless. Denotedas 'S'

$$S(forliquid) = \frac{Weightdensityof}{liquidWeightdensityof\ water}$$

7. Calculatethespecificweight,densityandspecificgravityof1litreofliquidwhichweighs 7 N.

Solution:

Given $V = 1ltre = \frac{1}{1000} m^3$

W=7 N

i. Sp.Weight(w)= $\frac{weight}{volume} = \frac{7N}{\frac{1}{1000}m^3} = 7000N/m^3$

ii Density(p)= $\frac{w}{g} = \frac{7000}{9.81} \frac{N}{m^3} kg/m^3 = 713..5 Kg/m^3$

iii. Sp.Gravity(S)= $\frac{Density of liquid}{Density of water} = \frac{713.5}{1000}$ (Densityof water =1000 kg/ $m^{3)}$

S =0.7135

8. State Newton's LawofViscosity. (Nov-Dec 2018)

Itstatesthattheshearstress(τ)onafluidelementlayerisdirectlyproportionaltotherateof shearstrain.Theconstantofproportionalityiscalledtheco-efficientofviscosity

$$\tau = \mu \frac{du}{dy}$$

9. Name the Types offluids.

1. Ideal fluid
2. Real fluid
3. Newtonianfluid
4. Non-Newtonianfluid.
5. Idealplastic fluid

10. Define KinematicViscosity.

It is definedas the ratio between the dynamicviscosityand densityof fluid.

Represented as γ ; $\upsilon = \frac{Viscosity}{Density} = \frac{\mu}{p}$

Unit: m^2/sec.

$$1 Stoke = \frac{Cm^2}{S} = \left(\frac{1}{100}\right)^2 \frac{m^2}{S} = 10^{-4} m^2/s.$$

Centistokemeans $= \frac{1}{100}$ —— *stoke*

11. FindtheKinematicviscosityofan oil havingdensity981 kg/m.Theshearstressat a point in oilis 0.2452N/m^{2}and velocity gradient atthat pointis 0.2/sec.

Mass densityp =981 kg/m^3, Shearstress $\tau = 0.2452 N/m^2$

Velocitygradient $\frac{du}{dy} = 0.2$

$$\tau = \mu \frac{du}{dy}$$

$$0.2452 = \mu \times 0.2 \quad \Rightarrow \mu = \frac{0.2452}{0.2} = 1.226 Ns/m^2.$$

$$kinematicviscosity(\upsilon) = \frac{\mu}{p} = \frac{1.226}{981}$$

$$= 0.125 \times 10^{-2}\ m^2/s.$$

$$= 0.125 \times 10^{-2} \times 10^4 cm^2/S$$

$$= 12.5 stoke.$$

12. Determinethe specificgravityof a fluid having viscosity 0.05 poise andKinematicviscosity 0.035 stokes.

Given: Viscosity,ʒ=0.05poise=(0.05/10)Ns/m^2.

KinematicviscosityĦ=0.035stokes=0.035cm^2/s

=0.035 x10^{-4}m^2/ s

$$\boxed{\upsilon = \frac{\mu}{p}}$$

$$0.035 \times 10^{-4} = \frac{0.05}{10} \times \frac{1}{p} \Rightarrow p = 1428.5 kg/m^3$$

Specificgravityof liquid= $\frac{\text{Densityof liquid}}{\text{Densityofwater}}$ = $\frac{1428.5}{1000}$=1.428

=1.43

13. Define Compressibility.

Compressibilityisthereciprocalofthebulkmodulusofelasticity,Kwhichisdefinedas theratio of compressive stress to volumetric strain.

V → Volume of gas enclosed in the cylinder
P → Pressureofgaswhen volumeis∀

Increase in pressure =dpkgf / m^2Decreaseof

volume =$d\forall$

∴ Volumetricstrain= $\frac{-d\forall}{\forall}$

- Vesign→ Volume decreaseswith increase in pressure

∴ Bulk modulus $K = \frac{Increase of Pressure}{Volumetric strain} = \frac{d_p}{\frac{-d\forall}{\forall}} = \boxed{-\frac{d_p}{d\forall}\forall}$

$$\boxed{Compressibility = \frac{1}{K}}$$

14. Define Surface Tension.

Surfacetensionisdefinedasthetensileforceactingonthesurfaceofaliquidincontactwith agasoronthesurfacebetweentwoimmiscibleliquidssuchthatthecontactsurface behaves likeamembrane under tension.

Unit: N / m.

15. Define Capillarity:

Capillaryisdefinedasaphenomenonofriseofaliquidsurfaceisasmalltuberelativetoadjacentgenerallevelofliquidwhenthetubeisheldverticallyintheliquid.Theresistanceofliquidsurfaceisknownascapillaryrisewhilethefalloftheliquidsurface is known as capillarydepression.It is expressed in terms of cm ormm of liquid.

16. TheCapillaryriseintheglasstubeisnottoexceed0.2mmofwater.Determineitsminimumsize,giventhatsurfacetensionofwaterincontactwithair=0.0725N/m

Solution:

Capillaryrise,h =0.2 mm=0.2

x10^3mSurfacetension$\sigma = 0.0725 N/m$

Let, Diameter of tube =

dAngelθ forwater =0

Densityfor water = 1000 kg/ m^2

$$h = \frac{4\sigma}{p \times g \times d} \Rightarrow 0.2 \times 10^{-3} = \frac{4 \times 0.0725}{1000 \times 9.81 \times d}$$

$$d = \frac{4 \times 0.0725}{1000 \times 9.81 \times 0.2 \times 10^{-3}} = 0.148m = 14.8cm$$

Minimum ϕ ofthetube=14.8 cm.

17.Findouttheminimumsizeofglasstubethatcanbeusedtomeasurewaterlevelifthecapillaryriseinthetubeistoberestrictedto2mm.Considersurfacetensionof water incontact with air as 0.073575 N/m.

Solution:

Capillaryriseh =2.0 mm $2.0 \times 10^{-3} m$

=Let,diameter=d

Densityofwater=1000 kg/ m^3

$\sigma = 0.073575 N/m$

Anglefor water$\theta = 0$

$$h = \frac{4\sigma}{\rho g d}$$

$$\Rightarrow 2.0 \times 10^{-3} = \frac{4 \times 0.073575}{1000 \times 9.81 \times d}$$

d =0.015 m = 1.5 cm.

Thus the minimum diameterof thetubeshould be1.5 cm.

18. Define Real fluid andIdealfluid.RealFluid:

Afluid,whichpossessesviscosity,isknownasrealfluid.Allfluids,inactualpractice,are real fluids.

IdealFluid:

Afluid,whichisincompressibleandishavingnoviscosity,isknownasanidealfluid.Ideal fluidisonlyanimaginaryfluidasallthefluids,whichexist,havesomeviscosity.

19. Writedown the expression for capillaryfall.

Heightofdepression in tube $h = \frac{4\sigma Cos\theta}{p \times g \times d}$

Where,

h = height of depression in tube.d = diameterof the

ı=surfacetension

ρ =densityof theliquid.

θ = Angle ofcontactbetween liquid andgas.

20. Twohorizontalplatesareplaced1.25cmapart.Thespacebetweenthembeingfilledwithoilofviscosity14poises.Calculatetheshearstressinoilifupperplateismoved with a velocity of2.5 m/s.

Solution:Given :

Distance between the plates, dy=1.25 cm = 0.0125m.

Viscosity ʒ=14poise=14/10Ns/m^2

Velocityofupper plate, u =2.5 m/Sec.

ShearstressisgivenbyequationasIJ=ʒ(du/dy).

Wheredu = change of velocitybetween the plates=u– 0 =u =2.5 m/sec.

dy=0.0125m.

IJ=(14/10)X(2.5/0.0125)=280N/m^2.

21. What is cohesion and adhesion in fluids?

Cohesion is due to the force of attraction between the molecules of the same liquid. Adhesion is due to the force of attraction between the molecules of two different liquids or between the molecules of the liquid and molecules of the solid boundary surface.

22. What is momentum equation/ the law of conservation of momentum

It is based on the law of conservation of momentum or on the momentum principle It states that,the net force acting on a fluid mass is equal to the change in momentum of flow per unit time in that direction.

23. What are the properties of ideal fluid?

Ideal fluids have following properties
i) intermolecular collisions are perfectly elastic
ii)It has zero viscosity
iii)Shear force is zero
iv) It is incompressible

24. What are the properties of real fluid?

Real fluids have following properties
i) It is compressible
ii)They are viscous in nature
iii)Shear force exists always in such fluids.

25. What are the different approaches for analysis of fluid mechanics?

Lagrangian approach and Eularian approach

26.What are the differences in Lagrangian approach and Eularian approach?

Lagrangian approach	**Eularian approach**
Considers fluid as a particle	Considers fluid as control volume
Ordinary differential is performed	Partial differential is involved

27. What are the features of Control mass system or closed system?

a)System of fixed mass or identity
b)No mass transfer across Boundary
c)Energy transfer may happen in or out of the system.
eg: A nuclear reactor.

28. What are the features of Control Volume System or open system?

a) System of fixed volume.
b)No transfer/change in volume but transfer of mass and energy may occur across control boundary.
c) Most of the engineering devices use this concept.
eg: Heat exchanger & pumps.

29. What are the features of an Isolated System?

a)System with fixed mass or fixed identity.
b)No interaction of mass or energy across the system boundary with the surroundings.
eg: Thermoflask.

30. What is called steady flow or stationary flow?
A flow in which the velocity and pressure of the fluid may vary from point to point but constant at a particular fixed point i.e. does not change with time.

31. What is called unsteady flow?
A flow in which the velocity and pressure of the fluid vary at a particular fixed point i.e. changes with time is called unsteady flow.

32. Write the types of steady flow and unsteady flow?
(a) steady uniform flow: velocity of fluid is same at each cross section and lives constant
(b) steady non-uniform flow: velocity and cross section may vary at positions but does not vary with time
(c) unsteady uniform flow: at a given instant of time velocity at every point is same but changes with time
(d) unsteady non-uniform flow: cross section and velocity vary from point to point and also changes with time while flowing through the channel.

UNIT – II

1. Define the term static fluid (Nov-Dec 2018)

When the fluid of consideration is static, or stationary or non-moving is called static fluid.We can calculate for example, fluid pressure at different depths (in the ocean) or altitudes (in the atmosphere) or the force (on a dam) due to the fluid.

2. Assumptionsmade inthe derivation ofBernoulli'sequation:

(i). Thefluid is ideal,i.e.,Viscosityis zero. (ii). The flow is steady(iii).

Teflow is incompressible. (iv). Theflow is irrotational.

3. Bernoulli'stheoremfor steady flowofanincompressiblefluid./ State Bernoulli'sequation. Write dimensions of each term involved. (Nov-Dec 2018)

Itstatesthatinasteady,idealflowofanincompressiblefluid,thetotalenergyatanypointofthefluid isconstant.Thetotalenergyconsistsofpressureenergy,kineticenergyandpotentialenergyor datumenergy.Theseenergiesperunitweightofthefluid are:

PressureEnergy =p / ρg Dimension: $\frac{P}{\rho g} = \frac{\frac{MLT^{-2}}{L^2}}{\frac{M}{L^3}\cdot\frac{L}{T^2}} = L$

Kinetic energy $=v^2/ 2g$ Dimension: $[L^2T^2/LT^2] = L$

Datum Energy =z Dimension: L

Bernoulli'stheorem is writtenas $(p/w) +(v^2/ 2g) +z=$Constant.

4.

Waterisflowingthroughapipeof5cmdiameterunderapressureof29.43N/cm^2(gauge)and withmeanvelocityof2.0m/s.findthetotalheadortotalenergyperunit weight of thewaterat cross– section, which is 5 cmabove the datumline.

Given:

Diameter ofthepipe 5 cm = 0.5 m.

Pressure ρ =29.43 N/cm^2=29.23 N/m^2

`

velocity, v =2.0 m/s.

datumhead z =5 m

totalheadpres = Pressurehead +Velocityhead +Datum head

sureheadkine = $(p/ \rho g)=(29.43X10^4/ (2X9.81))=30$ m

tic head $=(v^2/ 2g)=(2X2/(2X9.81))=0.204$ m

Totalhead $= (p/(\rho g))+ (v^2/ 2g)+z$

$=30 +0.204 +5=35.204$m

5. Wateris flowingthrough twodifferentpipes, towhich aninverteddifferentialmanometerhavinganoilofsp.Gr0.8isconnectedthepressureheadinthepipeAis 2 mofwater, find thepressure inthe pipeBforthemanometerreadings.

Prheadat$A$= $\frac{p_A}{= 2mpg}$ of water.

$$p_A = p \times g \times 2 = 1000 \times 9.81 \times 2$$

=19620 N/ m^2

Pr below X– X in left limb = $P_A - p_1gh_1$=19620 -1000 x781x 0.3 = 16677 N/m^2

P_r below X – X in right limb

$$p_B - 1000 \times 9.81 \times 0.1 - 800 \times 9.81 \times 0.12 = P_B - 1922.76$$

Equatingtwo pressures,we get,

$$P_B = 16677 + 1922.76 = 18599.76 \quad N/m^2 = 1.8599 \quad N/cm^2$$

6. Thediametersofapipeatthesections1and2are10cmand15cmrespectively.Findthedischargethroughthepipeifthevelocityofwaterflowingthroughthepipesection 1 is 5 m/s.determine also the velocityatsection 2.

Solution. Given:

Atsection 1. D_1=10 cm = 0.1 m.

A_1= (π/ 4) XD_1^2= (π/4)X $(0.1)^2$=0.007854 m^2.

V_1=5 m/s.

Atsection 2. D_2=15 cm = 0.15 m.

A_2= (π/ 4) X$(0.15)^2$=0.01767 m^2.

1. Discharge through pipe is givenbyequation

Q =A_1X V_1

=0.007544 X 5 =0.03927 m^3/ s.

Usingequation, We haveA_1V_1= A_2V_2..

V_2=(A_1V_1/ A_1) =(0.007854 /0.01767) X 5 =2.22 m/s.

7. What do you mean by hydrostatic law? / Pascal's Law (Nov-Dec 2018)

Pressure at any point inside a static fluid is equal towards all directions in the plane. The pressure at any point inside a fluid is a magnitude of compressive force or the normal compressive force acting per unit area over that point.

$P=h\rho g$, where P is applied pressure, h is height , is density of fluid and g is gravitational acceleration.

8. Apitot–statictubeisusedtomeasurethevelocityofwaterinapipe.Thestagnationpressureheadis6 mmandstaticpressureheadis5m.Calculatethevelocity offlowassuming the co-efficient of tube equal to 0.98.

Given:

StagnationPressure head,

h_s=6mm.S

tatic pressure h_t=5 mm.

h =6 – 5 =1 m

Velocityofflow V =C_v $\sqrt{2gh}$ =0.98 $\sqrt{2X9.81X1}$ =4.34 m/s.

9. Asub-marinemoveshorizontallyinaseaandhasitsaxis15mbelowthesurfaceofwater.Apitottubeproperlyplacedjustinfrontofthesub-marine andalongitsaxisconnectedtothetwolimbsofaU–tubecontainingmercury.Thedifferenceofmercurylevelisfoundtobe170mm.findthespeedofthesub-marineknowingthatthe sp.gr. of mercury is13.6 and that ofsea-water is 1.026 with respectfreshwater.

Given :

Diff. of mercurylevel x =170 mm =0.17

mSp. gr.Of mercury S_g=13.6

Sp. gr.Of sea-water S_o=1.026

∴ h=x$\left[Sg/So-1\right]$ =0.17$\left[(3.6/1.026)-1\right]$ =2.0834m

V = $\sqrt{2gh}$ = $\sqrt{2X9.81X20.834}$=6.393 m/s.

=(6.393X60X60 / 1000) km/hr =23.01 km/hr.

10. Writetheequations of motion.

$F_x = (F_g)_x + (F_p)_x + (F_v)_x + (F_t)_x + (F_c)_x$

Ifthe force dueto compressibility,$F_c$is negligible, the resultingnet force.

$F_x = (F_g)_x +$

$(F_p)_x + (F_v)_x + (F_t)_x$WhereF$_g$=gravityforce

F_p= Pressureforce

F_v=force dueto viscosityF$_t$=

force dueto turbulence

F_c= force duetocompressibility

11. State Euler'sEquationofmotion.

Venturimeter.

Venturimeterisadeviceusedformeasuringtherateofflowofafluidflowingthrough apipe.It consists of three pats(i). A short convergingpart(ii) Throat and (iii) Divergingpart.

Pitot–tube.

Pitottubeisadeviceusedformeasuringthevelocityofflowatanypointinapipeorchannel. Itisbasedontheprinciplethatifthevelocityofflowatapointbecomeszero.

Free liquidjet

Freeofliquidjetisdefinedasthejetofwatercomingoutfromthenozzleinatmosphere. Thepath traveledbythe free jet is parabolic.

Writedown the formulae forfinding the discharge inVenturimeter.

$$Q = C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} X \sqrt{2gh}$$

Wherea$_1$= area of the inletVenturimeter.a$_2$= area at the throat

C_d= co-efficientof venturemeter.

h=differenceofpressureheadintermsoffluidheadflowingthroughventuremeter

Dynamics offluidflow

Thestudyoffluidmotionwiththeforcescausingflowiscalleddynamicsoffluidflow.The dynamicbehaviorofthefluidflowisanalyzedbytheNewton'ssecondlawofmotion, which relates theacceleration with theforces.

Formulato find the maximumheight attainedby the jet

$$S = \frac{U^2 \sin^2\theta}{2g}$$

Where, S =maximum verticalheightattainedbythe particle.

U =velocityof jet of water.

g=acceleration duetogravity.

θ = anglewith horizontal direction.

Euler'sEquationofmotion.

This is equation ofmotion in which the forces dueto gravityand pressurearetaken into consideration.This is derived byconsideringthemotion of afluid elementalong a streamline in which flowis takingplaceins-directionas shown in fig. Consideracylindricalelement ofcross-section dA and length dS. Theforces actingon thecylindricalelementare:

a. Pressureforce pdAIn thedirection of flow.
b. Pressureforce $\left(p+\frac{\partial p}{\partial s}ds\right)dA$ oppositetothedirectionofflow.
c. Weight of element $\rho g dA ds$

Let θ istheanglebetweenthedirectionofflowandthelineofactionofthe weight of element.

Theresultantforceonthefluidelementof's'mustbeequaltothemass on the fluidelement X acceleration in the direction's'.

$$pdA-\left(p+\frac{\partial p}{\partial s}\right)dA-\rho g dA ds\cos\theta$$

$$=\rho dAdsXas--------(1)$$

Where$a_s$is the acceleration in the direction of 's'

Now, $a_s=\frac{dv}{dt}$, wherev is a function of 's'and't'.

$$=\frac{\partial v dv}{\partial s dt}+\frac{\partial v}{\partial t}=\frac{v\partial v}{\partial s}+\frac{\partial v}{\partial t}\left(\frac{ds}{dt}\right)=v$$

if the flow is steady, $\frac{dv}{dt}=0$

$$a_s=\frac{v\partial v}{\partial s}$$

Substitutingthevalueof'a_s'inequation(1)andsimplifyingthe equation, we get

$$-\frac{\partial p}{\partial s}dsdA - \rho gdAds\cos\theta = \rho dAdsX\ \frac{v\partial v}{\partial s}$$

$$Dividingby\rho dsdA, -\frac{\partial p}{\rho\partial s} - g\cos\theta = \frac{v\partial v}{\partial s}$$

$$or\frac{\partial p}{\rho\partial s} + g\cos\theta + v\frac{v\partial v}{\partial s} = 0$$

But fromfig, we have $\cos\theta = \frac{dz}{ds}$

$$\frac{1}{\rho}\frac{\partial p}{\partial s} + g\frac{dz}{ds} + \frac{v\partial v}{\partial s} = o$$

(or) $\frac{\partial p}{\rho} + gdz + vdv = 0$----------(2).

Equation 2 is known asEuler'sequation ofmotion

Thewaterisflowingthroughapipehavingdiameters20cmand10cm atsections1and2respectively.Therateofflowthroughpipeis35lit/sec.thesection1is6mabovedatum.Ifthepressureatsection2is4mabovethedatum.Ifthepressureatsection 1 is 39.24 N/cm^2, find the intensity of pressure at section2.

Given:

Atsection 1, D_1=20 cm = 0.2m

$A_1 = \frac{\Pi}{4}(0.2)^2 = 0.314m^2$.

P_1=39.24 N/cm^2= 39.24X10^{4}N/m^2.Z_1=6.0m

Atsection 2, D_2=0.10m

$A_2 = \frac{\Pi}{4}(0.1)^2 = 0.0785m^2$.

P_2=

Z_1=4.0m

Rate offlow Q =35 lit/sec =35/1000=0.035m^3/sQ

=A_1V_1= A_2V_2

V_1=Q / A_1=0.035 / 0.0314 =1.114 m/sV_2=Q / A_2=0.035 / 0.0785 =4.456 m/s.

Applying Bernoulli's Equations atsectionsat 1 and 2, we get

$$\frac{p_1}{\rho g}+\frac{V_1^2}{2g}+z_1=\frac{p_2}{\rho g}+\frac{V_2^2}{2g}+z_2$$

Or$(39.24X10^4/ 1000X9.81)+((1.114)^2/2X9.81)+6.0$

$=$

$(p_2/1000X9.81)+((4.456)^2/2X9.81)+4.040+0.063+6.0$

$=(p_2/9810)+1.012+4.0$

$46.063 =(p_2/9810) +5.012$

$(p_2/9810) =46.063 – 5.012 =41.051$

$p_2=(41.051X9810/10^4) =40.27$ N/cm^2

In a vertical pipeconveying oil ofspecificgravity0.8, two pressure gauges have beeninstalledatAandBwherethediametersare16cmand8cmrespectively.Ais2maboveB. thepressuregaugereadingshaveshownthatthepressureatBisgreaterthanatAby0.981N/cm^2.Neglectingalllosses,calculatetheflowrate.IfthegaugesatAandBarereplacedbytubesfilledwiththesameliquidandconnectedtoaU–tubecontainingmercury,calculatethedifferenceoflevelofmercuryinthetwo limbs ofthe U-tube.

Given:

Sp.gr.. ofoil, So =0.8

Density, ρ =0.8 X1000 =800 kg/m^3.

Dia at A, D_A=16 cm = 0.16m

Areaat A, $A_1= \frac{\Pi}{4} X(0.16)^2 = 0.0201$m^2.

Dia. At B D_B=8 cm = 0.08m

AreaatB, $A_B== \frac{\Pi}{4} X(0.08)^2 = 0.005026$m^2

(i).Difference of pressures, $p_B – p_A$=0.981N/cm^2.

=0.981 X 10^{4}N/m^2. =9810 N/m^2.

Difference ofpressurehead $(p_B – p_A)/\rho g$=(9810/ (800X9.81)) =1.25

ApplyingBernoulli'stheorematA andB andtaking referenceline passing through section B, weget

$$\frac{p_A}{\rho g}+\frac{V_A^2}{2g}+Z_A=\frac{p_B}{\rho g}+\frac{V_B^2}{2g}+Z_B$$

$$\frac{p_A}{\rho g} - \frac{p_B}{\rho g} + Z_A - Z_B = \frac{V_B^2}{2g} - \frac{V_A^2}{2g}$$

$$\frac{p_A - p_B}{\rho g} + 2.0 - 0.0 = \frac{V_B^2}{2g} - \frac{V_A^2}{2g}$$

$$-1.25 + 2.0 = \frac{V_B^2}{2g} - \frac{V_A^2}{2g} \qquad \frac{p_B - p_A}{\rho g} = 1.25$$

$$0.75 = \frac{V_B^2}{2g} - \frac{V_A^2}{2g} \text{----------(i)}$$

Now applying continuityequationat A andB, we get$V_A X A_1 = V_B X A_2$

$$V_B = \frac{V_A X A_1}{A_2} = \frac{V_A X \frac{\pi}{4}(.16)^2}{\frac{\pi}{4}(.08)^2} = 4V_A$$

Substitutingthe Value of$V_B$in equation(i), we get

$$0.75 = \frac{16V_A^2}{2g} - \frac{V_A^2}{2g} = \frac{15V_A^2}{2g}$$

$$V_A = \sqrt{\frac{0.75X2X9.81}{15}} = 0.99 m/s.$$

Rate offlow, $Q = V_A X A_1$

$= 0.99 \text{ X } 0.0201 = 0.01989 \text{ m}^3/\text{s}.$

(ii). Difference of mercuryin theU–tube.Let h= difference ofmercurylevel.

Then $h = x\left(\frac{S_g}{S_o} - 1\right)$

$= -1.25+2.0-0=0.75.$

$$\therefore 0.75 = x\left[\frac{13.6}{0.8} - 1\right] = x X 16$$

$x = (0.75 / 16)$

$= 0.04687$ cm.

Expression forloss ofhead due tofrictioninpipes or Darcy– Weisbach Equation.

Considerauniformhorizontalpipe,havingsteadyflowasshownfigure.Let1-1and2-2 is two sectionsofpipe.

Let P_1= pressure intensityat section 1-1.Let

P_2=Velocityofflowatsection 1-1.

L=length of the pipebetween the section 1-1 and2-2d = diameteroffpipe.

f^1= Frictionalresistanceper unit wettedarea per unit velocity.

h_f =loss of head dueto friction.

And P_2,V_2= arethe values of pressure intensityand velocityatsection2-2.

Applying Bernoulli'sequationbetween sections 1-1&2-2

Totalhead1-1= total head at 2-2 +loss of head dueto frictionbetween 1-1&2-2$(P_1/\rho g) + (V_1^2/ 2g) + Z_1 = (P_2/\rho g) + (V_2^2/ 2g) + Z_2 + h_f$----------(1)

but $Z_1=Z_1$[pipe is horizontal]

$V_1=V_2$[diameterof pipeis sameat 1-1&2-2]

(1) becomes,

$(P_1/ \rho g) = (P_2/\rho g) + h_f$

$h_f = (P_1/ \rho g) - (P_2/\rho g)$

Frictionalresistance =frictionalresistance per unit wettedarea per unit velocityXwettedarea X velocity^2.

F= $f^1 x \pi d_l x V^2$[Wettedarea = πd xL,and VelocityV=V_1=V_2]F_1= $f^1 x P x L x V^2$---------- (2). [πd = wetted perimeter =p]

Theforces actingon thefluid between section 1-1and2-2are,

1) Pressureforce at section 1-1 =P_1X A

2) Pressureforce at section 2-2 =P_2X A3).Frictional force F_1

Resolvingallforces in thehorizontal direction.,

$P_1A – P_2A – F_1 = 0$

$(P_1 - P_2)A =$

$F_1 = f^1 x P x L x V^2 (P_1 - P_2)$

$= (f^1 x P x L x V^2 / A)$.

Butfrom (1) weget

$P_1 - P_2 = \rho g h_f$

Equatingthe values of$(P_1 - P_2)$ we get

$\rho g h_f = (f^1 x P x L x V^2 / A)$.

$h_f = (f^1 / \rho g) X (P/A) X L X V^2$

$(P/A) = (\pi d / (\pi d^2/4)) =$

$(4/d)$Hence,$h_f = (f^1 / \rho g) x (4/d) x L x V^2$.

Putting$(f^1 / \rho) = (f / 2)$, where f is the co– efficient of friction

$$h_f = \frac{4fLV^2}{2gd}$$

ThisequationisknownasDarcy–Weisbachequation.Thisequationiscommonlyusedto find loss of head dueto friction in pipes.

Expression for rate offlowthroughVenturimeter.

Venturimeteris a device used for measuringthe rate offlow ofa fluid flowingthrough apipe.It consists of three pats(i). A short convergingpart(ii) Throat and(iii). Divergingpart

Let d_1=diameter at inletor atsection 1Let

P_1= pressure at section 1

Let V_1=velocityoffluidatsection 1

Leta = area of section 1 = $\frac{\pi}{4} d_1^2$

And d_2, P_2, V_2, $a_2$arethe correspondingvalues at section 2

ApplyingtheBernoulli'sequationatsection 1& 2

$(P_1/\rho g) + (V_1^2 / 2g) + Z_1 = (P_2/\rho g) + (V_2^2 / 2g) + Z_2$

sincethe pipeis horizontal $Z_1 = Z_2 (P_1/\rho g)$

$+ (V_1^2 / 2g) = (P_2/\rho g) + (V_2^2 / 2g)$

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

Weknow that $\frac{P_1 - P_2}{\rho g}$ is the differenceorpressureheadand isequal toh.

$$h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g} \text{----------(1).}$$

Now applying,continuityequation at 1 &2

$a_1V_1 = a_2V_2$ or $V_1 = (a_2V_2 / a_1)$ ---------- (2).

Sub (2) in equation(1) we get

$$h = \frac{V_2^2}{2g} - \frac{\left(\frac{a_2 V_2}{a_1}\right)^2}{2g} = \frac{V_2^2}{2g}\left[1 - \frac{a_2^2}{a_1^2}\right]$$

$$V_2^2 = 2gh\,(a_1^2/(a_1^2 - a_2^2))$$

$$V_2 = \sqrt{2gh}.\frac{a_1}{\sqrt{a_1^2 - a_2^2}}$$

Discharge, $Q = a_2 V_2$

$$Q = \frac{a_2 a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}} \text{ theoreticaldischarge}$$

Actualdischarge

$$Q_{act} = C_d X \frac{a_2 a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

Where C_d = co – efficient of venturimeter.

WaterflowsthroughapipeAB1.2mdiameterat3m/sandthenpassesthroughapipeBC1.5 m diameteratC,thepipe branches.BranchCDis0.8mindiameterandcarriesonethirdoftheflowinAB.Theflowvelocityinbranchcis2.5m/s.FindthevolumerateofflowinAB,thevelocityinBC,thevelocityinCDandthediameter ofCE.

Solution. Given:

Diameter ofPipe AB,	D_{AB}=1.2
m.VelocityofflowthroughAB	V_{AB}=3.0
m/s.Dia. of Pipe BC,	D_{BC}=1.5m.
Dia. of Branched pipe CD,	
	D_{CD}=0.8m.Ve
locityofflow in pipeCE,	V_{CE}=2.5
m/s.Let therate offlow in pipe	AB=Q m^3/s.
Velocityofflow in pipe	BC =$V_{BC}$$m^3$/s.
Velocityofflow in pipe	CD =$V_{CD}$$m^3$/s.

Diameter ofpipe CE

$=D_{CE}$Then flowrate through CD =Q / 3

And flowrate through CE =Q– Q/3 =2Q/3

(i). Nowthe flowratethrough AB=Q =V_{AB}X Area ofAB

$=3 X (\pi/ 4) X(D_{AB})^2=3 X (\pi/ 4) X(1.2)^2$

$=3.393 m^3/s.$

(ii). Applyingthecontinuityequation to pipeABand pipe BC,V_{AB}X

Area of pipeAB=V_{BC}xArea of PipeBC

$3 X (\pi/ 4) x(D_{AB})^2= V_{BC}x(\pi/ 4) x(D_{BC})^2$

$3 x(1.2)^2 = V_{BC}x(1.5)^2$

$V_{BC} =(3x1.2^2)/ 1.5^2=1.92 m/s.$

(iii). Theflow rate through pipe

$CD =Q_1=Q/3 =3.393 /3 =1.131 m^3/s.$

$Q_1= V_{CD}$xArea of pipe $C_D x(\pi/ 4) (C_{CD})^2$

$1.131 = V_{CD}x(\pi/ 4) x(0.8)^2$

$V_{CD}=1.131 / 0.5026 = 2.25 m/s.$

(iv).Flowthrough CE,

$Q_2=Q– Q_1=3.393 – 1.131 =2.262 m^3/s.$

$Q_2= V_{CE}$X Area of pipe CE =$V_{CE}X (\pi/ 4) (D_{CE})^2$

$2.263 =2.5 X (\pi/ 4) (D_{CE})^2$

$D_{CE}= \sqrt{(2.263X4)/ (2.5 X \pi)} =1.0735 m$

Diameter ofpipeCE =1.0735m.

AhorizontalVenturimeterwithinletandthroatdiameters30cmand15cmrespectivelyisusedtomeasuretheflowofwater.Thereadingofdifferentialmanometerconnectedtotheinletandthethroatis20cmofmercury.Determinetherate offlow.TakeC_d= 0.98.

Given:

d_1=30 cm

$a_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(30)^2$

$= 706.85 \text{ cm}^2$

$d_2 = 15$ cm

$a_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(15)^2$

$= 176.7 \text{ cm}^2$

$C_d = 0.98$

Readingofdifferential manometer =x=20 cmofmercury.

Differenceofpressurehead, $h = x\left(\frac{S_h}{S_o} - 1\right)$

=20 [(13.6 / 1) – 1]=252.0 cm of mercury.

$$Q_{act} = C_d \times \frac{a_2 a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$

$$= 0.98 \times \frac{706.85 x 176.72 \sqrt{x 9.81 x 252}}{\sqrt{706.85^2 - 176.7^2}}$$

$= 125756 \text{ cm}^3/\text{s}$

= 125.756 lit / s.

UNIT – IV

BOUNDARYLAYERANDFLOWTHROUGHPIPES

Definitionofboundarylayer–Thicknessandclassification–Displacementandmomentumthickness–Developmentoflaminarandturbulentflowsincircularpipes–Major andminorlossesofflowinpipes –Pipesinseriesandinparallel –Pipe network

Hydraulicgradientline.

Itisdefinedasthelinewhichgivesthesumofpressurehead(P/ρg)anddatumhead(z)ofaflowingfluidinapipewithrespecttosomereferencelineoristhelinewhichisobtainedbyjoiningtheto pofallverticalordinates,showingthepressurehead (P/ρg)ofa pipefromthecenter ofthe pipe.It isbriefly writtenasH.G.L

Majorenergylossandminorenergylossinpipe

Thelossofheadorenergyduetofriction in pipeisknownasmajorlosswhilethelossofenergyduetochangeofvelocityoftheflowingfluidinmagnitude ordirectioniscalledminorlossofenergy.

TotalEnergyline

Itisdefinedastheline,whichgivessumofpressurehead,datumheadandkineticheadofaflowingfluidinapipewithrespecttosomereferenceline.

Equivalentpipeline

An Equivalentpipe isdefinedasthepipe of uniformdiameterhavinglossof headanddischargeofacompoundpipeconsistingofseveralpipesofdifferentlengthsanddiameters.

WaterHammerinpipes.

Inalongpipe,whentheflowingwaterissuddenlybroughttorestbyclosingthevalveorbyanysimilarcause,therewillbeasuddenriseinpressureduetothemomentumofwaterbeingdestroyed.Apressurewaveistransmittedalongthepipe.Asuddenriseinpressurehastheeffectofhammeringactiononthewallsofthepipe.Thisphenomenonofriseinpressureisknownaswater hammerorhammer blow.

Pipesinseries:

Pipesinseriesorcompoundpipesisdefinedasthepipesofdifferentlengths anddifferentdiametersconnectedendtoend(inseries)toformapipeline.

Pipesinparallel:

Thepipesaresaidtobeparallel,whenamainpipedividesintotwoormoreparallelpipes,wh ichagainjointogetherdownstreamandcontinuesasamainline.Thepipesareconnectedinparallel inordertoincreasethedischargepassingthroughthemain.

Boundarylayer.

Whenasolidbodyisimmersedinaflowingfluid,thereisanarrowregionofthefluidinneig hbourhoodofthesolidbody,wherethevelocityoffluidvariesfromzerotofreestreamvelocity.Thi snarrowregionoffluidiscalledboundarylayer.

laminarsublayer

Inturbulentboundarylayerregion,adjacenttothesolidboundaryvelocityforasmallthick nessvariationininfluencedbyvariouseffect.Thislayeriscalledaslaminarsublayer.

Boundarylayerthickness.

Itisdefinedasthedistancefromtheboundaryofthesolidbodymeasuredinthey –directiontothepointwherethevelocity ofthefluidisapproximatelyequalto0.99timesthefreestream(v)velocity ofthefluid.

momentumthickness.

Itisdefinedasthedistance,measuredperpendicularttotheboundaryofthesolidbody,byw hichtheboundaryshouldbedisplacedtocompensateforthereductioninmomentum oftheflowingfluidofboundary

$$\theta = \int_0^{\delta} u/v(1-u/v)dy$$

Incompressibleflow.

Itisdefineasthe typeofflowinwhichthe densityisconstant forthe fluidflow. Mathematicallyρ=constant.Examples:Subsonic,aerodynamics.

Differentmethodsofpreventingtheseparation ofboundarylayers

1. Suctionofslowmovingfluidbysuctionslot
2. Supplyingadditionalenergyfromablower
3. Providingabypassintheslottedwring
4. Rotating boundaryinthedirectionofflow.
5. Providingsmalldivergenceindiffuser
6. Providingguide–blades inabend.

Exampleslaminarflow/viscousflow

(i) Flowpasttinybodies,

(ii) Undergroundflow

(iii) Movementofbloodinthearteries ofhumanbody,

(iv) Flowofoilinmeasuringinstruments,

(v) Riseofwater inplants throughtheir rootsetc.,

Characteristicsoflaminarflow

(i) Noslipattheboundary

(ii) Duetoviscosity,thereisashearbetweenfluidlayers,whichisgivenby

$\tau = \mu(du/dy)$for flowin x- direction

(iii) Theflowisrotational.

(iv) Duetoviscousshear, thereiscontinuous dissipation ofenergyand formaintainingtheflowmustbesuppliedexternally.

(v) Lossofenergyisproportionaltofirstpowerofvelocityandfirstpowerofviscosity.

(vi) Nomixingbetweendifferentfluidlayers(exceptbymolecular motion,whichisverysmall)

Differentiatebetweenlaminarboundarylayerandturbulentboundarylayer

Theboundarylayer iscalledlaminar,iftheRenoldsnumberoftheflowisdefined asR$_e$=U**x**X/ v isless than 3X10^5

IftheRenoldsnumberismorethan5X10^5,theboundarylayeriscalledturbulentbo undary.

Where,U=FreestreamvelocityofflowX=

Distancefromleadingedgev=Kin

ematic viscosityoffluid

Chezy'sformula.

Chezy'sformulaisgenerallyusedfortheflowthroughopenchannel.

$$V=C\sqrt{mi}$$

Where,C=chezy'sconstant,m=hydraulicmeandepthandi=h$_f$/L.

Acrudeof oil ofkinematic viscosity of0.4stokeisflowing through apipe ofdiameter 300mmattherate of300litres/sec. findtheheadlostduetofrictionfora length of50mof thepipe.

Given:

Kinematicviscosity v=0.4 stoke=0.4 cm^2/s =0.4X 10^{-4}m^2/sDia.Ofpipe d=300mm=0.3m

Discharge Q=300Lit/S=0.3m^3/s

Lengthofpipe L=50m

Velocity V=Q/Area =0.3/($\frac{\pi}{4}$ (0.3)^2)=4.24 m/s

Renoldnumber R$_e$=(V Xd)/v=(4.24X 0.30)/ 0.4X10^{-4}=3.18X 10^{4}AsR$_e$liesbetween 4000and100,000,the value of"f"isgiven by

$$\frac{0.079}{(R_e)^{1/4}}=\frac{0.079}{(3.18X10^4)^{1/4}}=0.00591$$

Headlost dueto frictionh$_f$=4fL V^2/ 2gd

=(4 X 0.00591 X50X 4.24^2) /(0.3 X 2 X9.81)

=3.61m

Findthetypeof flowofanoil ofrelative density0.9anddynamic viscosity20poise,flowingthroughapipeof diameter 20cmandgivinga dischargeof10lps.

Solution:

s=relativedensity=Specific gravity=0.9

μ =Dynamic viscosity=20poise=2Ns/m^2.

Dia of pipeD=0.2 m; Discharge Q=10 lps=(10/1000) m^3/s; Q= AV.

SoV =Q /A =[10 /(1000 X($\frac{\pi}{4}$ (0.2)^2))]=0.3183 m/s.

Kinematic viscosity =v=μ /ρ=[2/(0.9X1000)]=2.222X10^{-3} m^2/

s.ReynoldsnumberRe=VD/v

Re=[0.3183X0.2/2.222X10^{-3}]=28.647;

Since Re(28.647)<2000,

Itis**Laminarflow.**

Formula forfindingthelossofheadduetoentrance of pipeh_i

h_i =0.5 (V^2/2g)

FormulatofindtheEfficiencyofpowertransmissionthroughpipes

n= (H– h_f) /H

where,H=totalheadatinletofpipe.h_f

=headlostdue tofriction

Hydrodynamically smoothpipecarrieswaterattherate of300lit/sat20°C(ρ = 1000 kg/m^3, ν = $10^{-6}$$m^2$/s) with a headloss of3m in100m length of pipe.Determinethepipediameter.Use f=0.0032+(0.221)/(R_e)$^{0.237}$equationforfwhereh$_f$= (fXLXV^2)/2gd andR$_e$= (ρVD/μ)

Given:

Discharge, Q=300lit/sec=

0.3m^3/sDensity

ρ =1000kg/m^3

Kinematicviscosityν =$10^{-6}$$m^2$/sHeadloss h_f=3m

Lengthofpipe,L=100m

Value offrictionfactor, f=0.0032+0.221/ (R_e)$^{0.237}$

Renolds numberR$_e$=(ρVD/μ)=(VXD)/ν (μ/ρ =ν)

VXD/10^{-6}=VXDX10^6

Finddiameterofpipe.

LetD=diameterofpipe

Headlossinterms offriction factor isgiven as

h_f=(fXLXV^2)/2gXD

3=

(fX100XV^2)/2X9.81XDf=(3

XDX2X9.81)/100V^2

f= 0.5886D/V^2----------(i)

nowQ =AXV

$0.3=(\frac{\pi}{4}D)^2$X Vor D^{2}X V=(4X 0.3 /π) = 0.382

V^2=0.382/D^2---------- (ii)

f=0.0032+(0.221)/(R_e)$^{0.237}$

0.5886/ D^2=0.0032+(0.221)/(VXDX10^6)$^{0.237}$

{fromequation(i),f=0.5886D/V^{2}andR$_e$=VXDX10^6}

$$0.5886D/(0.382/D^2)^2=0.0032+\frac{0.221}{\left(\frac{0.382}{D^2}XDX10^6\right)^{0.237}}$$

{fromEquation(ii), V=0.382/D^2}

$$0.5886xD^5/0.382^2=0.0032+\frac{0.221}{\left(\frac{(0.382X10^6)^{0.237}}{D^{0.237}}\right)}$$

4.0333D^5=0.0032+0.0015XD$^{0.237}$

4.0333D^5–0.0105D$^{0.237}$–0.0032=0----------(iii)

theaboveequation(iii)willbesolvedhittrialmethod

(i).AssumeD=1m,thenL.H.Softheequation(iii),becomesasL.H.S=4.

033X1^5–0.0105X1$^{0.237}$– 0.0032

=4.033– 0.0105– 0.0032=4.0193

byincreasingthevalueofDmorethan1m,theL.H.S.willgoonincreasing.Hencedec

reasethevalueofD.

(ii) Assume

D=0.3thanL.H.Sofequation(iii)becomesasL.H.S

=4.033X0.3$^{0.237}$–0.0032

$$=0.0098–0.00789–0.0032=-0.00129$$

asthisvalueofnegative,thevaluesofDwillbeslightlymorethan0.3

(iii) AssumeD=0.306thenL.H.Sofequation(iii)becomesas

$$L.H.S=4.033X0.306^{0.237}–0.0105X0.306^{0.237}– 0.0032$$

$$=0.0108– 0.00793–0.0032=-0.00033$$

ThisvalueofL.H.Sisapproximatelyequaltoequaltozero.Actuallythevalue ofDwill beslightlymorethan0.306msay**0.308m**.

Expressionforlossofheadduetofrictioninpipes.

OrDarcy–WeisbachEquation.

Considerauniformhorizontalpipe,havingsteadyflowasshownfigure.Let1-1and2-2aretwosections ofpipe.

LetP$_1$=pressureintensityatsection1-1.LetP$_2$=Velocityofflowatsection 1-1.

L=lengthofthepipebetweenthe section1-1and2-2d=diameteroffpipe.

f^1=Frictional resistanceperunitwettedareaperunitvelocity.h$_f$ =lossofhead duetofriction.

AndP$_2$,V$_2$=arethevalues ofpressureintensityandvelocityatsection2-2.ApplyingBernoulli'sequationbetweensections1-1&2-2

Totalhead1-1=totalheadat2-2+lossofheadduetofrictionbetween1-1&2-2

$$(P_1/\rho g)+(V^2/2g)+ Z_1= (P_2/\rho g) + (V^2/2g)+Z_2+h_f\text{----------}(1)$$

butZ$_1$=Z$_1$[pipeishorizontal]

V$_1$=V$_2$[diameter ofpipe issameat 1-1&2-2]

(1) becomes,

$$(P_1/\rho g)=(P_2/\rho g)+h_f h_f=(P_1/\rho g)- (P_2/\rho g)$$

frictionalresistance=frictionalresistanceperunitwettedareaperunitvelocityXwettedareaXvelocity^2.

F=f^{1}XπdlXV^2[Wettedarea=πdXL,andVelocityV=V$_1$=V$_2$]

$F_1=f^1XPXLXV^2$----------(2).[π d= wetted perimeter=p]Theforcesactingonthefluidbetweensection1-1and2-2are,

1) Pressureforceatsection 1-1=P_1XA

2) Pressureforceat section 2-2=P_2XA3).Frictional forceF_1

Resolvingallforcesinthehorizontaldirection.,

$P_1A – P_2A– F_1= 0$

$(P_1-P_2)A=$

$F_1=f^1XPXLXV^2(P_1-P_2)=(f^1XPXLXV^2/A)$.

Butfrom(1)weget

$P_1– P_2=\rho g\ h_f$

Equatingthevalues of$(P_1–P_2)$wegetρgh_f

$=(f^1XPXLXV^2/A)$.

$h_f =(f^1/\rho g)X(P/A)\ X\ LX\ V^2(P/A)=$

$(\pi\ d/\ (\pi\ d^2/4))=(4/d)$

hence,$h_f=(f^1/\rho g)X(\ 4/d)\ X\ LXV^2$.

Putting $(f^1/\ \rho)=(f/2)$,where fis theco –efficient offriction

$$h_f= \frac{4fLV^2}{2gd}$$

ThisequationisknownasDarcy–Weisbachequation.Thisequationiscommonlyusedtofindlossofheaddue tofrictioninpipes

Therate offlowthroughahorizontal pipeis0.25m^3/s.thediameter ofthepipewhichis200mmissuddenly enlarged to400mm.thepressure intensity inthesmaller pipeis11.772 N/cm^2.Determine (i).Lossof headduetos uddenenlargement(ii).Pressureintensityinlargepipe.(iii).Powerlostduetoenl argement.

Given:

Discharge $Q=0.25\ m^3/s.$

Dia.Ofsmallerpipe D_1=200mm=0.2m

Area $A_1 = (\frac{\pi}{4} 0.2)^2 = 0.03141\ m^2$.

Diaoflargepipe D_2=400mm=0.4m

Area $A_2 = (\frac{\pi}{4} 0.4)^2 = 0.12566\ m^2$.

Pressureinsmallerpipe p_1=11.772 $N/cm^2 = 11.772X10^4 N/m^2$.Nowvelocity $V_1 = Q/A_1 = 0.25/0.03414 =$ 7.96 m/s.

Velocity $V_2 = Q/A_2 = 0.25/0.12566 = 1.99$ m/s.(i).Lossofheadduetosuddenenlargement,

$$h_e = (V_1 - V_2)^2/2g = (7.96 - 1.99)^2/2X\ 9.81 = \mathbf{1.816\ m}.$$

(ii).Letthepressureintensityinlargepipe=p_2.

ThenapplyingBernoulli'sequationbeforeandafterthesuddenenlargement,

$$(P_1/\rho g)+(V^2/2g)+Z_1 = (P_2/\rho g)+(V_2^2/2g)+Z_2+h_e$$

But$Z_1=Z_2$

$$(P_1/\rho g)+(V^2/2g) = (P_2/\rho g)+(V_2^2/2g)+h_e$$

$$\text{Or } (P_1/\rho g)+(V^2/2g) = (P_2/\rho g)+(V_2^2/2g)+Z_2+h_f$$

$$(P_2/\rho g) = (P_1/\rho g)+(V^2/2g)-(V_2^2/2g)-h_e$$

$$= \frac{11.772X10^4}{1000X9.81} + \frac{7.96^2}{2X9.81} - \frac{1.99^2}{2X9.81} - 1.816$$

=12.0+3.229-0.2018-1.8160

=15.229–20.178=13.21mofwater

$p_2 = 13.21X\ \rho g = 13.21X100X\ 9.81\ N/m^2$

$=13.21X1000X9.81X10^{-4} N/cm^2. = \mathbf{12.96 N/cm^2}.$

(iii).Powerlostduetosuddenenlargement,

$$P=(\rho g\mathbf{Qh_e})/\ 1000=(1000X9.81X0.25X1.816)/1000 =\mathbf{4.453kW.}$$

Ahorizontalpipeline40mlongisconnectedtoawatertankatoneendanddischargesfreelyintotheatmosphereattheotherend.Forthefirst25mofitslengthfromthetank,thepipeis150mmdiameterissuddenlyenlargedto300mm.theheightofwaterlevelinthetankis8mabovethecentreofthepipe.Consideringalllossesofhead,whichoccur.Determinetherateofflow.Takef=0.01forboth sectionsofthepipe.

Given:

Totallengthofpipe,

L=40mL

engthof1stpipe, L_1=25m

Diaof1st pipe

d_1=150mm=0.15mL

engthof2nd pipe L_2=40–25=15mDia

of2nd pipe

d_2=300mm=0.3mHei

ghtofwater H=8m

Co-effi.Offriction f= 0.01

ApplyingtheBernoulli's theoremtothesurfaceofwaterinthetankandoutlet ofpipeasshowninfig.andtakingreference line passingthroughthecenterofthepipe.

$0+0+8=(P_2/\rho g)$

$+(V_2^2/2g)+0+$alllosses$8.0=0+(V_2^2/$

$2g)+h_i+h_{f1}+h_e+h_{f2}$

Where, h_i=lossofhead atentrance=$0.5V^2/2g$ 1

h_{f1}=headlost duetofrictioninpipe 1= $\frac{4XfXL_1 XV_1^2}{d_1X2g}$

h_e=lossofheaddueto suddenenlargement=$(V_1-V_2)^2/2g$

h_{f2}=head lostdue tofriction inpipe 2 $= \frac{4XfXL_2 XV_2^2}{d_2X2g}$

Butfromcontinuityequation,wehave

$A_1V_1= A_2V_2$

$V_1=(A_2V_2/A_1) = \frac{\frac{\pi}{4} d_2^2 XV_2}{\frac{\pi}{4} d_1^2} = \left(\frac{d_2}{d_1}\right)^2 XV_2 = \left(\frac{0.3}{0.15}\right)^2 XV_2 = 4V_2$

SubstitutingthevalueofV1indifferentheadlosses,wehaveh_i=0.5

$V_i^2/2g =(0.5X(4V_2)^2)/2g=8V_2/2g$ 2

$h_{f1}= \frac{4X0.01X25X(4V_2)^2}{0.15X2g} = \frac{4X0.01X25X16}{0.15} X \frac{V_2^2}{2g} = 106.67\frac{V_2^2}{2g}$

he $=(V_1- V_2)^2/ 2g$ $= (4V_2- V_2)^2/2g=9V_2^2/2g$

$h_{f2}= \frac{4X0.01X15X(V_2^2)}{0.3X2g} = \frac{4X0.01X15}{0.3} X \frac{V_2^2}{2g} = 2.02\frac{V_2^2}{2g}$

Substitutingthevaluesoftheselossesinequation(i),weget

$8.0= \frac{V_2^2}{2g}+ \frac{8V_2^2}{2g} +106.67\frac{V_2^2}{2g} + \frac{9V_2^2}{2g} + 2X \frac{V_2^2}{2g}$

$= V_2^2 [\frac{V_2^2}{2g}+8+106.67+9+2]=126.67 V_2^2 \frac{V_2^2}{2g}$

$V_2= \sqrt{\frac{8.0x2xg}{126.67}} = \sqrt{\frac{8.0X2X9.81}{126.67}} = 1.113$m/s

Rate of flow $Q=A_2XV_2=\frac{\pi}{4}(0.3)^2X1.113=0.07867m^3/s$ =**78.67litres/sec.**

Apipeline,300mmindiameteramd3200mlongisusedtopumpup50kgpersecondof anoilwhosedensityis950nkg/m³.andwhoseKinematicviscosityis2.1stokes.Thece nterofthepipeatupperendis40mabovethanatthelowerend.Thedischargeattheup perendisatmospheric.Findthepressureatthelowerendanddrawthehydraulicgra dientandthetotalenergyline.

Given:

Diaofpipe d=300mm=0.3m

Lengthofpipe L=3200m

Mass M=50kg/s =ρ.Q

Discharge $Q=50/\rho= 50/950=0.0526\ m^3/s$

Density $\rho=950kg/m^3$

Kinematicviscosity ν =2.1stokes=$2.1cm^2/s=2.1X10^{-4}m^2/s$Heightofupperend =40m

Pressureatupper end=atmospheric=0

Renoldsnumber,$R_e=VXD/\nu$,whereV=Discharge/Area

$$=0.0526/(\frac{\pi}{4}(0.3)^2)=0.744\ m/s$$

$$R_e=(0.744X0.30)/(2.1X10^{-4}) =1062.8$$

Co–efficient offriction,

$f=16/R_e=16/1062.8=0.015$Headlostduetofriction,h_f

$$=\frac{4XfXL\ XV^2}{d\ X2g}=\frac{4X0.015X3200X(0.744)^2}{0.3X2X9.81}=18.05m\text{of oil.}$$

ApplyingtheBernoulli'sequationatthelower andupperendofthepipeandtakingdatumlinepassingthroughthelowerend,wehave

$(P_1/\rho g)+(V^2/2g)+Z_1=(P_2/\rho g)+(V^2{}_2/2g)+Z_2+h_f$

but$Z_1=0$,$Z_2=40$m., $V_1=V_2$asdiameterissame.

$P_2=0$,$h_f=18.05$m

Substitutingthesevalues,wehave

$=5400997 N/m^2=54.099 N/cm^2$.

H.G.L.ANDT.E.L.

$V^2/2g=(0.744)^2/2X9.81=0.0282$m

$p_1/\rho g=58.05$m of oil$p_2/\rho g$

=0

Drawahorizontalline AXasshowninfig.FromAdrawthecenterline ofthepipeinsuchwaythatpointCisadistanceof40mabovethehorizontalline.DrawaverticalineABthroughAsuchthatAB=58.05m.JoinBwithC.then BCisthehydraulicgradientline.

DrawalineDEparallel toBCataheightof0.0282mabovethehydraulicgradientline.ThenDEisthetotalenergyline.

Amainpipedividesintotwoparallelpipes,whichagainformsonepipeasshown.The lengthanddiameterfor the firstparallelpipeare2000mand1.0mrespectively,whilethelength and diameterof2nd parallelpipeare2000mand 0.8m.Find therateofflowineachparallelpipe,iftotalflowinmainis3.0m³/s.theco-efficientoffriction foreach parallelpipeissameandequal to0.005.

Given:

LengthofPipe1

L_1=2000m

Diaofpipe1

d_1=1.0mLe

ngthofpipe2

L_2=2000m

Dia ofpipe2 d_2=0.8m

Totalflow

Q=3.0m^3/sf

$_1 = f_2 = f = 0.005$

letQ$_1$=dischargeinpipe1letQ$_2$=dis

chargeinpipe2

fromequation, $Q = Q_1 + Q_2 = 3.0$----------

(i)usingtheequationwehave

$$\frac{4Xf_1XL_1XV_1^2}{d_1X2g} = \frac{4Xf_2XL_2XV_2^2}{d_2X2g}$$

$$\frac{4X0.005X2000XV_1^2}{1.0X2X9.81} = \frac{4X0.005X2000XV_2^2}{0.8X2X9.81}$$

$$\frac{V_1^2}{1.0} = \frac{V_2^2}{0.8} \; or \; V_1^2 = \frac{V_2^2}{0.8}$$

$$V_1 = \frac{V_2}{\sqrt{0.8}} = \frac{V_2}{0.894}$$

Now, $Q_1 = \frac{\pi}{4} d_1^2 X V_1 = \frac{\pi}{4} (1)^2 X (V_2/0.894)$

And $Q_2 = \frac{\pi}{4} d_2^2 X V_2 = \frac{\pi}{4} (0.8)^{2X} (V_2) = (\frac{\pi}{4} 0.64) X (V_2)$

Substitutingthe valueofQ$_1$andQ$_2$in equation(i)weget

$$\frac{\pi}{4}(1)^2 X(V^2)(0.894) + \frac{\pi}{4}(0.64) X(V^2) = 3.0 \text{ or } 0.8785\, V^2 + 0.5026 V^2 = 3.0$$

$V^2[0.8785+0.5026] = 3.0$ or $V = 3.0 / 1.3811 = 2.17$ m/s.

Substitutingthisvalueinequation(ii),

$V_1 = V_2 / 0.894 = 2.17/0.894$ m/s

Hence $Q_1 = \frac{\pi}{4} d_1^2 X V_1 = \frac{\pi}{4} 1^2 X 2.427 =$ **1.096 m³/s**

$Q_2 = Q - Q_1 = 3.0 - 1.906 =$ **1.904 m³/s**.

ThreereservoirsA,B,Careconnectedbyapipesystemshowninfig.Findthedischargeintoorfromthereservoirs BandCiftherateofflowfromreservoirsAis60litres/s.findtheheightofwaterlevelinthereservoirC.takef= 0.006forallpipes.

Given:

LengthofpipeAD, L_1=1200m

Dia ofpipeAD,

d_1=30cm=0.3mDischarget

hroughAD, Q_1=60lit/s

=0.06m³/sHeightofwaterlevelinAfromreferenceline,Z_A=4

0m

ForpipeDB,length

L_2=600mm,Dia.,d_2=20cm=0.20m,Z_B=38.0Forpi

peDC,length L_3=800mm,Dia.,d_3=30cm=0.30m,

ApplyingtheBernoulli's equationstopoint E and A, $Z_D = Z + \frac{p_D}{\rho g} + h_f$

Where $h_f = \frac{4Xf_1 XL_1 XV_1^2}{d_1 X2g}$, where $V_1 = Q_1$/ Area =0.006/($(\frac{\pi}{4}0.3)^2$)=0.848 m/s.

$h_f = \frac{4X0.006X1200X0.848^2}{0.3X2X9.81} = 3.518$m.

$\{Z + \frac{p_1}{\rho g}\}_D = 40.0 - 3.518 = 36.482$m

HencepiezometricheadatD=36.482m.Hencewater

flowsfromBtoD.ApplyingBernoulli’sequationtopointBandD

$$Z_B = \{Z_D + \frac{p_D}{\rho g}\} + h_{f2} \text{ or } 38 = 36.482 + h_{f2}$$

h_{f2}=38–36.482=1.518m

$$\text{But } h_{f2} = \frac{4XfXL_2\ XV_2^2}{d_2X2g} = \frac{4X0.006X600XV^2{}_2}{0.2X2X9.81}$$

$$1.518 = \frac{4X0.006X600XV_2^2}{0.2X2X9.81}$$

$$V_2 = \sqrt{\frac{1.518X0.2X2X9.81}{4X0.006X600}} = 0.643m/s$$

Discharge $Q_2 = V_2 X \left(\frac{\pi}{4}d_2\right)^2 = 0.643X \frac{\pi}{2} X(0.2)^2$ = **0.0202m³/s=20.2lit/s.**

ApplyingBernoulli'sequationtoDandC

$$\{Z_D + \frac{p_D}{\rho g}\} = Z_C + h_{f3}$$

$$36.482 = Z_C + \frac{4XfXL_3XV_3^2}{d_3X2g} \quad where, V_3 = \frac{Q_3}{\frac{\pi}{4}d_3^2}$$

butfromcontinuity $Q_1+Q_2=Q_3$

$$Q_3 = Q_1 + Q_2 = 0.006 + 0.0202 = 0.0802\ m^3/s$$

$$V_3 = \frac{Q_3}{\frac{\pi}{4}d_3^2} = \frac{Q_3}{\frac{\pi}{4}(0.9)^2} = 1.134m/s$$

$$36.482 = Z_C + \frac{4X0.006X800X1.134^2}{0.X2X9.81} = Z_C + 4.194$$

Z_C =36.482–4.194=**32.288m**

APipelineoflength2000misusedforpowertransmission.If110.365kWpoweristobetransmittedthroughthepipeinwhichwaterhavingpressureof490.5 N/cm²at inletisflowing.Find thediameterofthepipeandefficiency

oftransmissionifthepressuredropoverthelengthofpipeis98.1N/cm^2.Takef=0.0065

.

Given:

Lengthofpipe L=2000m.

H.Ptransmitted =150

Pressureatinlet, p=490.5

N/cm^2=490.5X10^{4}N/m^2.Pressureheadat inlet, H=p/ρg

Pressuredrop =98.1N/cm^2=98.1X10^4/m^2

Lossofhead h_f=98.1 X10^4/ρg=98.1X10^4/ (1000X9.81) =100mCo–efficient offrictionf=0.0065

Headavailable at the end ofthepipe =H–h_f=500–100=400mLetthediameterofthepipe=d

Nowpower transmittedisgivenby,

P= [ρgXQX (H– h_f)] / 1000 kW.

110.3625= [1000X9.81XQX400] /1000

Q=[110.3625X1000/ (1000X9.81X400)]= 0.02812m^3/s

But dischargeQ= AXV = $\frac{\pi}{4}$ d^{2}XV

$\frac{\pi}{4}$ d^{2}X V=0.02812

V= (0.02812 X4) / 3.14 Xd^2= 0.0358 /d^2----------(1)

Total headlostduetofriction,

$$h_f = \frac{4fXLXV^2}{dX2g}$$

but, h_f =100m

$$100 = h_f = \frac{4XfXL\ XV^2}{d\ X2g} = \frac{4X0.0065X2000XV^2}{dX2X9.81} = \frac{2.65XV^2}{d}$$

=(2.65/d)X(0.358/d^2)^2=0.003396/d^{5}V=

fromequation(1),

0.0358/d^2

$100=0.003396/d^5$

$d=(0.00396/100)^{1/5}=0.1277m=127.7mm.$

Efficiencyofpowertransmissionisgivenbyequation

$$\eta=\frac{H-h_f}{H}=\frac{500-100}{500}=0.80=80\%$$

UNIT –V

SIMILITUDEANDMODELSTUDY

DimensionalAnalysis–Rayleigh'smethod,Buckingham'sPi-theorem–Similitudeandmodels–Scaleeffectanddistortedmodels

Dimensionalanalysis.

Dimensionalanalysisisdefinedasamathematicaltechniqueusedinresearchworkfor designandconductingmodeltests.

Fundamentaldimensions

Thefundamentalunitsquantitiessuchaslength(L),mass(M),andtime (T)arefixeddimensionsknownasfundamentaldimensions.

Units.

Unitisdefinedasayardsticktomeasurephysicalquantitieslikedistance,area, volume,massetc.

Derivethedimensionsforvelocity.

Velocityisthedistance(L)travelledperunittime(T)Velocity=Distan ce/Time=[L/T]=LT^{-1}.

Model

Modelisnothingbutsmall-scalerepetitionoftheactualstructureormachine.

Listouttheadvantagesofmodel analysis.

Theadvantagesofmodelanalysisare:

1. Theperformanceofhydraulicstructureormachinecanbeeasilypredicted inadvancefromitsmodel.
2. Themeritsofalternativedesigncanbepredictedwiththehelpofmodeltestingandth emosteconomicalandsafedesignmaybefinallyadopted.

PCH 8302 SOLIDS MECHANICS FOR TECHNOLOGISTS

UNIT I

STRESS, STRAIN AND DEFORMATION OF SOLIDS

1. Define Stress and its types
2. Define Strain
3. Define Elastic limit
4. State Hooke's law.
5. Define tensile stress and tensile strain.
6. Define Young's modulus
7. Define Longitudinal strain
8. Define Lateral strain
9. Defineshear stress and shear strain.
10. Define volumetric strain.
11. Define Poisson's ratio.
12. Define Bulk-modulus
13. Define Shear modulus or Modulus of rigidity [NOV/DEC 2018]
14. State the relationship between Young's Modulus and Modulus of Rigidity.
15. Give the relationship between Bulk Modulus and Young's Modulus.
16. What is principle of super position?
17. What is compound bar?
18. What you mean by thermal stresses?
19. Define principle stresses and principle plane.
20. Define strain energy.
21. State principle plane.
22. What is the difference between equilibrium and stability?
23. Determine the poison's ratio and bulk modulus of material for which young's modulus is 1.2×10^5 N/mm^2 and modulus of rigidity is 4.8×10^4 N/mm^2.[NOV/DEC 2018]

UNIT II

TRANSVERSE LOADING ON BEAMS

1. Define Beam

.

2. What is mean by transverse loading on beam?
3. What is Cantilever beam?
4. What is simply supported beam?
5. What is mean by over hanging beam?
6. What is mean by concentrated loads?

7. What is uniformly distributed load (udl).

8. Define point of contra flexure? In which beam it occurs?

9. What is mean by positive or sagging BM?

10 What is mean by negative or hogging BM?

11. Define shear force and bending moment?

12. When will bending moment is maximum?

13. What is maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' over entire span?

14. In a simply supported beam how will you locate point of maximum bending moment?

15. What is shear force and bending moment diagram?

16. What are the types of beams?

17. What are the types of loads?

18. Write the assumptions in the theory of simple bending?

19. Define: Neutral Axis

20. Define: Moment of resistance

21. Define: Section modulus

22. What is shear force?

23. In which point the bending moment is maximum?

24. Draw the shear and bending moment diagrams for cantilever of length L carrying a point load W at the free end? [NOV/DEC 2018]

25. List out some important points for drawing shear force and bending moment diagrams [NOV/DEC 2018]

UNIT III

DEFLECTIONS OF BEAMS

1. Define: Moment of resistance

2. What is the deflection of a beam?

3. What are the methods to find slope and deflection?

4. What is slope and deflection in beams?

5. What causes beam deflection?

6. What is maximum deflection of a beam?

7. How do you control beam deflection?

8.What is the maximum permissible deflection limit for a cantilever beam?

9. What is allowable deflection?

10. Why is beam deflection important?

11. Why moment area method is more useful, when compared with double integration?

12. Explain the Theorem for conjugate beam method?

13. Define method of Singularity functions?

14. What are the points to be worth for conjugate beam method?

15. DefineMohr's Theorem for slope

16.Define Mohr's Theorem for deflection

17. What do you mean by shear stress in beams?

18. State the relation between curvature, slope and deflection at a section.

19. List out the points used in Macaulay's method.

20. Write an expression for deflection by moment area method.

21. Write an expression for the deflection at the centre of a simply supported beam carrying a point load at the centre.

22. A cantilever of length 3 m is carrying a point load of 25 kN at the free end. If the moment of inertia of the beam is 10^8 mm^4 and the value of E is 2.1 x 105 N/mm2 .Find the deflection at the free end.

23. What is meant by propped cantilever?

24. A cantilever of length 4 m carries a uniformly varying load of zero at the free end and 50 kN at the fixed end. If I = 10^8 mm^4 and E = 2.1 x 10^5 N/mm^2, find the deflection at the free end.

25. What is a conjugate beam?

26. What is meant by Double-Integration method?

27.Define deflection. [NOV/DEC 2018]

28.What do you mean by flexural rigidity? [NOV/DEC 2018]

UNIT IV

STRESSES IN BEAMS

1.What do you mean by shear stress in beams?[NOV/DEC 2018]

2. Write the assumption in the theory of simple bending?

3. Write the theory of simple bending equation?

4. What types of stresses are caused in a beam subjected to a constant shear force?

5. State the main assumptions while deriving the general formula for shear stresses

6. Define Shear stress distribution

7. What is the ratio of maximum shear stress to the average shear stress for the rectangular section?

8. What is the ratio of maximum shear stress to the average shear stress in the case of solid circular section?

9. What is the maximum value of shear stress for triangular section?

10. What is the shear stress distribution value of Flange portion of the I-section?

11. What is the value of maximum of minimum shear stress in a rectangular cross section?

12. Define Section modulus. [NOV/DEC 2018].

13. How do you calculate beam deflection?

14. Why I section of beam are generally used?

15. How do you calculate allowable bending stress?

16. How do you calculate allowable stress?

17. What is the maximum permissible deflection limit for a cantilever beam?

18. Define leaf spring.

19. Define Flitched beam.

20. Where will you find the maximum shear stress in a beam?

21. How do you calculate shear stress?

22. What is a spring?

23. State any two functions of springs.

24. What are the various types of springs?

25. Classify the helical springs.

26. Define helical springs.

UNIT V

TORSIONAND COLUMNS

1. Define Torsion.

2. Write torsional equation

3. Write the assumptions in the theory of pure torsion.

4. Define Polar Modulus
5. Write the equation for the polar modulus for solid circular section
6.What are the assumptions made in Torsion equation

7. Write the polar modulus for solid shaft and circular shaft.
8. Why hollow circular shafts are preferred when compared to solid circular shafts?
9. How is torsional stiffness of a shaft calculated?
11. Classify the helical springs.

12. Define helical springs.

13. What is deflection of spring?

14. What is deflection of helical springs?

15. Write the deflection of spring formula.

16. What is spring index (C)?

17. Write the polar modulus for solid shaft and circular shaft.
18. Define: Column and strut.

19. Define spring constant.

20. Write the Euler's theory of long columns

21. What is buckling of columns?
22. What is slenderness ratio of column?
23. What is eccentricity of column?
24. What is minimum eccentricity of column?
25. What is short column and long column?
26. What are the types of column failure?
27. Write the Euler's formula for different end conditions.[NOV/DEC 2018]
28. What are the limitations of the Euler's formula?
29. Define Equivalent length of the column.
30. Write Euler's formula for maximum stress for a eccentrically loaded column?

31. A solid shaft of 150mm diameter is used to transmit torque. Find the maximum torque transmitted by the shaft if the maximum shear stress induced to the shaft is 45N/mm^2. [NOV/DEC 2018]

PART B

UNIT-I

PART – B (13 Marks)

1. A tensile test was conducted on a mild steel bar. The following data was obtained from the test:

   (i) Diameter of the steel bar = 3 cm

   (ii) Gauge length of the bar = 20cm

   (iii) Load at elastic limit = 250 kN

   (iv) Extension at a load of 150 kN = 0.21 mm

   (v) Maximum load = 380 kN

   (vi) Total extension = 60 mm

   (vii) Diameter of rod at failure = 2.25 cm

   Determine:

   (1) The Young's modulus

   (2) The stress at elastic limit

   (3) The percentage of elongation

   (4) The percentage decrease in area.

2. Three bars made of copper; zinc and aluminium are of equal length and have cross section 500, 700, and 1000 sq.mm respectively. They are rigidly connected at their ends. If this compound member is subjected to a longitudinal pull of 250 kN, estimate the proportional of the load carried on each rod and the induced stresses. Take the value of E for copper = 1.3×10^5 N/mm^2, for zinc = 1×10^5 N/mm^2 and for aluminium = 0.8×10^5 N/mm^2.

3. A bar 0.3m long is 50mm square in section for 120mm of its length, 25mm diameter for 80mm and of 40mm diameter for its remaining length. If the tensile force of 100kN is applied to the bar calculate the maximum and minimum stresses produced in it, and the total elongation. Take $E = 2\times10^5$ N/mm^2 and assume uniform distribution of stress over the cross section.
4. A bar of 25mm diameter is subjected to a pull of 40kN. The measured extension on gauge length of 200mm is 0.085mm and the change in diameter is 0.003mm.Calculate the value of Poisson's ratio and the three moduli.
5. A cylindrical vessel, whose ends are closed by means of rigid flange plates, is made up of steel plate 3 mm thick. The length and internal diameter of the vessel are 50 cm and 25

cm respectively. Determine the longitudinal and hoop stresses in the cylindrical shell due to an internal fluid pressure of 3 N/mm^2. Also calculate the increase in length, diameter and volume of vessel. Take $E = 2\times10^5$ N/mm^2 and $\mu = 0.3$.

6. A hollow cylinder 2 m long has an outside diameter of 50 mm and inside diameter of 30 mm. If the cylinder is carrying a load of 25 kN, find the stress in the cylinder. Also find the deformation of the cylinder, if the value of modulus of elasticity for the cylinder material is 100 GPa.
7. A cylindrical shell of 500 mm diameter is required to withstand an internal pressure of 4 MPa. Find the minimum thickness of the shell, if maximum tensile strength for the plate material is 400 MPa and efficiency of the joints is 65%. Take factor of safety as 5.
8. A cylindrical shell 3m long which is closed at its ends has an internal diameter of 1m and a wall thickness of 15mm. calculate the circumferential and longitudinal stresses induced and also change in dimensions of the shell if it is subjected to an internal pressure of 1.5 MN/m^2
9. A short metallic column of $500mm^2$ cross sectional area carries a axial compressive load of 100kN.For a plane inclined at 60° with the direction of the load calculate i) Normal stress ii) Resultant stress iii) Tangential stress iv) Maximum shear stress v) Obliquity of resultant stress.
10. (i) Derive a relation for change in length of a bar hanging freely under its own weight. (6) (ii) Draw stress - strain curve for a mild steel rod subjected to tension and explain about the salient points on it. (10)
11. (i) Derive the relationship between bulk modulus and young's modulus. (6)

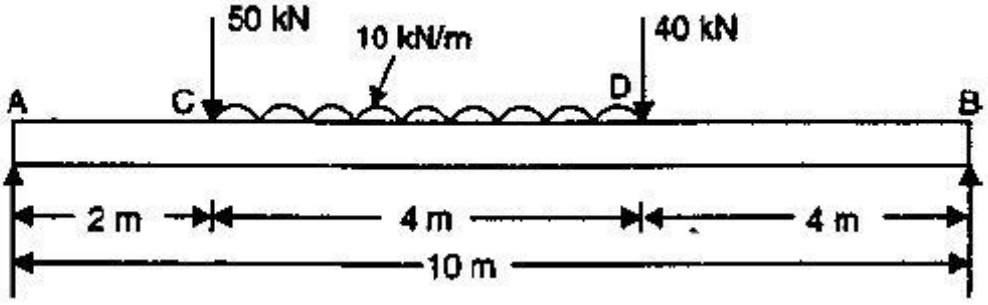
(ii) Derive relations for normal and shear stresses acting on an inclined plane at a point in a stained material subjected to two mutually perpendicular direct stresses. (10)

12. Two vertical rods one of steel and other of copper are rigidly fixed at the top and 80cm apart. Diameter and length of each rod are 3cm and 3.5m respectively. A cross bar fixed to the rods at lower ends carries a load of 6kN such that the cross bar remains horizontal even after loading. Find the stress in each rod and position of

load on the bar. Take E for steel as 2×10^5 N/mm^2 and for copper as 1×10^5 N/mm^2

UNIT II

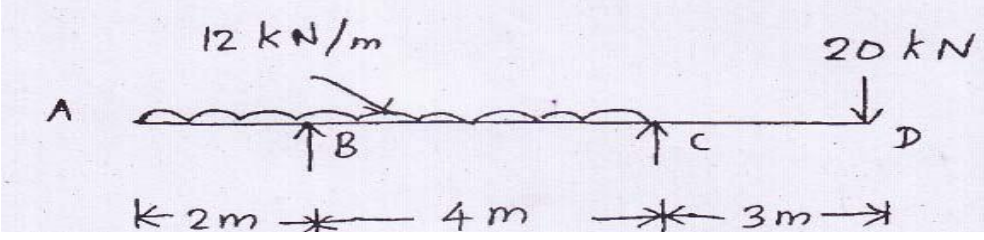
1. A simply supported beam of length 10m carries the uniformly distributed load and two point loads as shown in Fig. Draw the S.F and B.M diagram for the beam and also calculate the maximum bending moment.



2. (i) Derive an expression for bending moment equation (8)

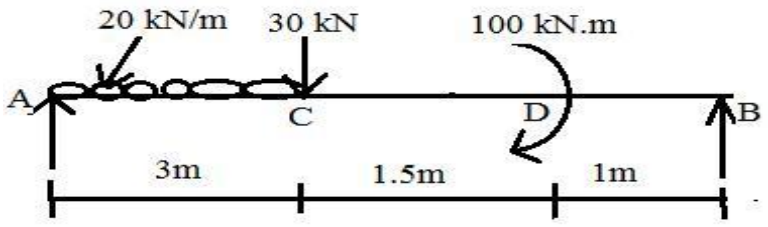
   (ii) A rectangular beam 300 mm deep is simply supported over the span of 4 m. Determine the uniformly distributed load per metre which the beam may carry, if the bending stress should not exceed 120N/mm^2. Take I=8×10^6 mm^4. (8)

3. A cantilever beam of 2 m long carries a uniformly distributed load of 1.5 kN/m over a length of 1.6 m from the free end. Draws shear force and bending moment diagrams for the beam.
4. A simply supported beam 6 m long is carrying a uniformly distributed load of 5 kN/m over a length of 3 m from the right end. Draw shear force and bending moment diagrams for the beam and also calculate the maximum bending moment on the beam.
5. Draw shear force and bending moment diagram for the beam given in Fig.



6. State the assurnptions made in the theory of simple bending and derive the bending formula.
7. A 100mm X 200mm rolled steel I section has the flanges 12mm thick and web 10mm thick. Find
   (i) The safe udl the section can carry over a span of 6m if the permissible stress is limited to 150 N/mm^2
   (ii) The maximum bending stress when the beam carries a central point load of 20kN.

8. The cross section of T beam is as follows: Flange thickness = 10mm; width of the flange = 100mm; thickness of the web = 10mm; depth of the web = 120mm; If a shear force of 2kN is acting at a particular section of the beam draw the shear stress distribution across the section.
9. An overhanging beam ABC is simply supported at A & B over a span of 6m and BC overhangs by 3m. If the supported span AB carries a central concentrated load of 8kNand overhang span BC carries 2kN/m draw the shear force and bending moment diagram.
10. A simply supported beam of span 4m carries a udl of 6kN/m over the entire span. If the maximum allowable stress due to bending is restricted to 150 N/mm^2, determine the cross sectional dimensions if the section is;
    (i) Rectangular with depth twice the breadth
    (ii) Solid circular section
    (iii)Hollow circular section having a diameter ratio of 0.6
11. Draw shear force and bending moment diagram for the beam shown in Fig.



12. A flitched beam consists of two timber joist 100mm wide and 240mm deep with a steel plate 180mm deep and 10mm thick placed symmetrically between the timber joists and well clamped. Determine
    i) The maximum fibre stress when the maximum fibre stress in wood is 80 kg/cm^2.
    ii) The combined moment of resistance if the modular ratio is 18.

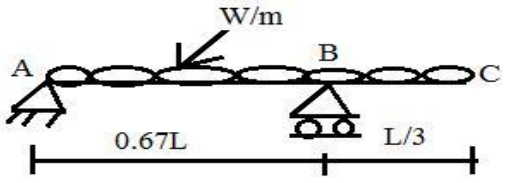
UNIT -III

1. A beam of length 6 m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Find
   (i) Deflection under each load
   (ii) Maximum deflection
   (iii)The point at which the maximum deflection occurs.

   Take $I=85\times10^6$ mm^4 $E = 2\times10^5$ N/mm^2

2. A steel joist, simply supported over a span of 6 m carries a point load of 50 kN at 1.2 m from the left hand support. Find the position and magnitude of the maximum deflection. Take EI = 14 X 10^{12} N/mm^2

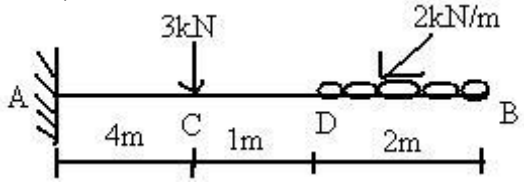
3. For the beam shown in fig show that the deflection at the free end is $WL^4/684EI$. Use Macaulay's method.



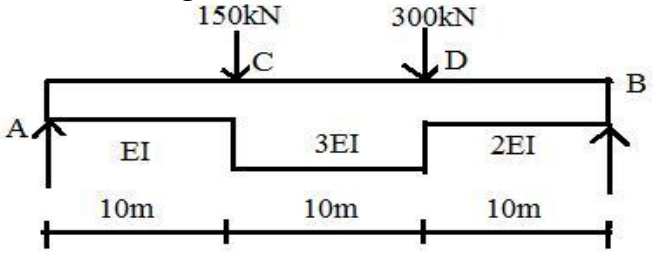
4. A cantilever of length 2.5m is loaded with an udl of 10 kN/m over a length 1.5m from the fixed end. Determine the slope and deflection at the free end. Determine the slope and

   deflection at the free end of the cantilever L = 9500cm^4, E = 210 GN / m^2 Using Moment area method.

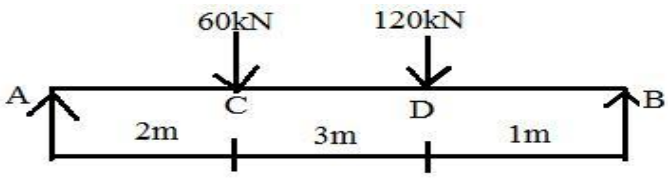
5. Find the slope and deflection at the free end of the cantilever shows in fig.
   Take EI = 1x10^{10} kN/mm^2



6. Using conjugate beam method, obtain the slope and deflections at A, B, C and D of the beam shown in fig. Take E = 200GPa and I = 2x10^{-2} m^4.



7. Obtain the deflection under the greater load for the beam shown in fig using the conjugate beam method.



8. A simply supported beam of span 3 m is subjected to a central load of 10 kN. Find the maximum slope and deflection of the beam. Take I = 12 $\times 10^6$ mm^4 and E = 200 GPa.

9. A beam AB of span 6m is simply supported at its ends is subjected to a point load of 20kN at C at a distance of 2m from left end. Using moment area method, Compute the deflection at the point C, slope at the points A, B and C. Take I = 6 x10^8 mm^4 and E = 200GPa.

10. A steel cantilever of 2.5m effective length carries a load of 25kN at its free end. If the deflection at the free end is not exceed 40mm. What must be the I value of the section of the cantilever. Take E = 210 GN/m2 using moment area method.

UNIT-IV

1. i) Derive the torsion equation for a circular shaft of diameter‘d’ subjected to torque ‘T’.
   ii) Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm^2.

2. A close coiled helical spring is made of a round wire having ‘n’ turns and the mean coil radius R is 5 times the wire diameter. Show that the stiffness of the spring = 2.05 R/n. If the above spring is to support a load of 1.2kN with 120mm compression. Calculate mean radius of the coil and number of turns assuming G = 8200 N/mm^2 and permissible shear stress, $\lambda_{allowable}$ = 250 N/mm^2.

3. A steel shaft ABCD having a total length of 2400mm is contributed by three different sections as follows. The portion AB is hollow having outside and inside diameters 80mm and 50mm respectively, BC is solid and 80mm diameter. CD is also solid and 70mm in diameter. If the angle of twist is same for each section, determine the length of each portion and the total angle of twist. Maximum permissible shear stress is 50 MPa and shear modulus $0.82x10^5$ MPa.

4. It is required to design a close coiled helical spring which shall deflect 1mm under and axial load of 100N at a shear stress of 90 MPa. The spring is to be made of round wire having shear modulus of $0.8x10^5$ MPa. The mean diameter of the coil is to times that at the coil wire. Find the diameter and length of the wire.

5. A solid circular shaft transmits 75kW power at 200rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed one degree in 2m length of shaft and shear stress is not exceed 50 N/mm^2. Assume the modulus of rigidity of the material of the shaft as 100 kN/mm^2.
6. A shaft has to transmit 110 kW at 160rpm. If the shear stress is not to exceed $65N/mm^2$ and the twist in a length of 3.5m must not exceed 1o, find a suitable diameter. Take C = 8x104 N/mm^4.
7. A leaf spring 750mm long is required to carry a central load of 8kN. If the central deflection is not to exceed 20mm and the bending stress is not to be greater than

200N/mm^2. Determine the thickness, width and number of plates. Assume the width of the plates is 12 times, their thickness and modulus of elasticity of the springs material as 200kN/mm^2.

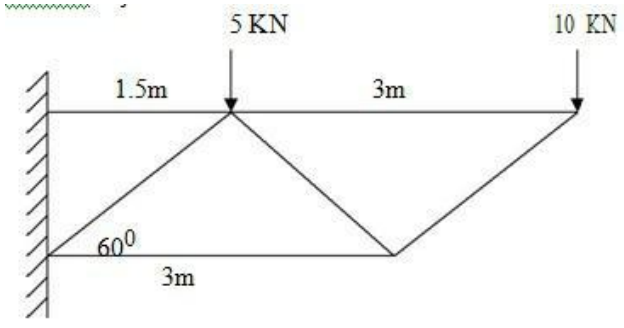
8. A closely coiled helical spring made out of a 10mm diameter steel bar has 12 complete coils, each of mean diameter of 100mm. Calculate the stress induced in the section of rod, the deflection under the pull and the amount of energy stored in the spring during the extension. It is subjected to an axial pull of 200N. Modulus of rigidity is 0.84x10^5 N/mm^2.
9. A close coiled helical spring has a stiffness of 5N/mm. its length when fully compressed with adjacent coils touching each other is 40 cm. the modulus of rigidity of the material of the spring is 8x10^4 N/mm^2. Determine the wire diameter and mean coil diameter if their ratio is 1/10. What is the corresponding maximum shear stress in the spring?
10. A circular shaft of 1000mm diameter and 2m length is subjected to a twisting moment which creates a shear stress of 20N/mm^2 at 30mm from the axis of the shaft. Calculate the angle of twist and the strain energy stored in the shaft. Take G=8x10^4 N/mm^2.

UNIT -V

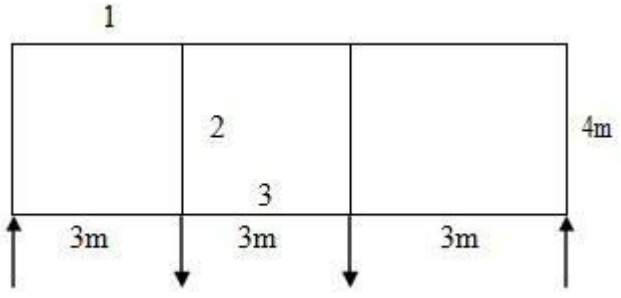
1.A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 47 N/mm^2 on the plane at right angle to the former. Each of the above stress is accompanied by a shear stress of 63 N/mm^2 Find (i) The direction and magnitude of each of the principal stress (ii) Magnitude of greatest shear stress.

2.At a point in a strained material, the principal stresses are100 N/mm^2 (T) and 40 N/mm^2 (C). Determine the resultant stress in magnitude and direction in a plane inclined at 60^0 to the axis of major principal stress. What is the maximum intensity of shear stress in the material at the point?

3.A cantilever truss is show in fig. Find the forces in the members of the truss by the method of joint



4.A truss of span 9m is loaded as shown in fig. Find the reaction and forces in the members marked 1, 2, and 3 by using method of section.



5.At a point in a strained material, the principal stresses are 100 N/mm2 (T) and 40 N/mm2 (C) Determine the direction and magnitude in a plane inclined at 600 to the axis of major principal stress. What is the maximum intensity of shear stress in the material at the point

6. Find the magnitude and nature of the forces in the given truss carrying loads as shown in Fig. 12(a).

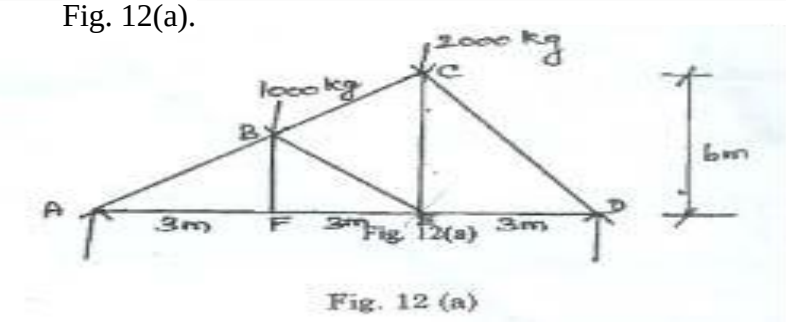
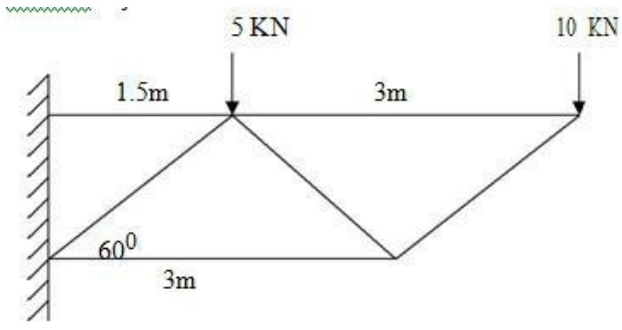


Fig. 12 (a)

7.A SS truss is show in fig. Find the forces in the members of the truss by the method of joint Fig. 12(a).

8.A cantilever truss is show in fig. Find the forces in the members of the truss by the

method of section



9. The principal stress in the wall of a container are 40 MN/m^2 and 80 MN/m^2. Determine the normal, shear and resultant stresses in magnitude and direction in a plane, the normal of which makes an angle of 30° with the direction of maximum principal stress.

10. Determine the normal, shear and resultant stress in magnitude and direction in plane, the normal of which makes an angle of 30° with the direction of $30MN/m^2$ stress (Tensile). The Value of other tensile stress is $15MN/m^2$

EE8352 - PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIT I - ELECTRICAL CIRCUITS

PART – A

1. **What are the components of a power system?**

   The components of power systems are Generators, Step up and Step down transformers, Loads and Transmission lines.

2. **What is meant by primary and secondary transmission?**

   Transmission of electric power at 110Kv, 132Kv, 400Kv, 765KV by three phase 3 wire overhead system is known as primary transmission. Transmission of electric power at 33KV by three phase 3 wire overhead system is known as secondary transmission.

3. **What are the transmission level voltages we have in India?**

   Primary transmission level voltage is 132 KV, 220KV, 440KV, 750KV and secondary transmission level voltage is 33KV or 66KV.

4. **What is meant by primary and secondary distributions?**

   The secondary transmission lines terminates at the substations where voltage is reduced from 33KV to 11KV lines which run along the road sides of the city forms the primary distribution. A primary distribution line terminates at the distributing substations where voltage is reduced from 11KV to 400 volts. Thus three phase 4 wire system which connect the distributing substation and the consumer point forms the secondary distribution.

5. **Why all transmission and distribution systems are three phase systems?**

   A three phase A.C circuit using the same size conductors as the single phase circuit can carry three times the power which can be carried by a single phase circuit and uses three conductors for the three phases and one conductor for the neutral. Thus a three phase circuit is more economical than a single phase circuit in terms of initial cost as well as the losses. Therefore all transmission and distribution systems are three phase systems.

6. **State the advantages of interconnected systems.**

   Any area fed from one generating station during overload hours can be fed from another power station and thus reserved capacity required is reduced, reliability of supply is increased and efficiency is increased.

7. **Mention the limitations of using very high transmission voltage.**

   Limitations are (a) increased cost of insulation of conductors, (b) transformers switches gears and other terminal apparatus.

8. **Why DC transmission is economical and preferable over AC transmission for large distances only?**

   Because with larger distances, the saving in cost of DC overhead lines become greater than the additional expenditure on terminal equipment.

9. **Mention the problems associated with an EHV transmission?**

   The problems associated with EHV transmission are corona loss and radio interference, requirements of heavy supporting structures and their erection difficulties, and high insulation requirements.

10. **What are the advantages of high voltage AC transmission?**

(i) The power can be generated at high voltages. (ii)The maintenance of AC substations is easy and cheaper.(iii) The total line cost per MW per km decreases considerably with the increase in line voltage (iv) The line can be easily tapped and extended with simple control of power flow in the network

11. What are the primary constants of transmission lines?

Resistance, inductance, capacitance and conductance distributed uniformly along the length of the line are called constants or parameters of transmission line.

12. Define resistance of transmission line?

Resistance of transmission line in a single phase is defined as the loop resistance per unit length of line. (Loop resistance is nothing but the sum of resistances of both the wires for unit line length).In a three phase, it is defined as the resistance per phase. (i.e) resistance of one conductor

13. Define inductance of transmission line. Give its unit.

Inductance is defined as the ratio of flux linkage to unit current. Its unit is Henry.

$$L = \frac{\psi}{I}$$

14. Define capacitance of transmission line.

Capacitance is defined as shunt capacitance between the two wires per unit line length (or) the capacitance between the conductors in a transmission line is the charge per unit potential difference. Its unit is Farad per meter.

15. State Ohm's law

Ohm's law states that the current flowing in a conductor is directly proportional to the potential between two ends of a conductor.i.e. i α v, v = iR,

16. State the Limitation of Ohm's law

Ohm's law doesn't apply to all non-metallic conductors2. Doesn't apply to nonlinear devices like Zener diode, Voltage regulator, tubes etc.,3. It is not applicable for the metallic conductors which changes with temperature

17. Define i) charge ii) electric current iii) power iv) network& v) circuit.

Charge: Charge is an electrical property of the atomic particles of which matter consists, measured in coulombs(C).

Electriccurrentis the time rate of change of charge, measured in amperes (A). i =dq/dt

A direct current (DC) is a current that remains constant with time.

An alternating current (AC) is a current that varies sinusoidally with time

Power is the time rate of expending or absorbing energy, measured in watts(w).p = $\frac{dw}{dt}$

p- Power in watts(w);w- energy in joules (J);t - time in seconds (S);(or) p = v i ,v - Voltage in volts(V);i - current in amperes(A).

Network: The inter connection of two or more simple circuit elements forms an electricalnetwork.

Circuit: If the network contains at least one closed path, it is an electric circuit.

18. StateKirchoff's Current law.

KCL (Kirchoff's Current Law) states that the algebraic sum of currents entering a node is zero (or)The sum of the currents entering a node is equal to the sum of the currents leaving the node.

State Kirchoff'sVoltage law.

KVL (Kirchoff's Voltage Law) states that the algebraic sum of all voltages around a closed path is zero. (or) Sum of voltage drop = Sum of voltage rise.

19. What do you meant by series and parallel circuit?

When circuit elements like resistors are connected in series, such that the same current passes through all of them, then they are said to be in series.When circuit elements are connected across one another such that the same voltage is applied to each, then the are said to be in parallel.

20. What are the disadvantages of series circuit?

If a break occurs at any point in the circuit no current will flow and the entire circuit becomes useless.Series circuit is not practicable for lighting circuitsElectrical devices have a different current ratings, they cannot be connected in series for efficient operation.

21. The total charge entering a terminal is given by q=5t sin 4πt, mC. Calculate the current at t=0.5 seconds.

i = dq/dt =d (5t sin 4πt)/dt = (5 sin 4πt +20 πtcos 4πt)

At t = 0.5, i = 5 sin 2π+ 10πcos 2π= 0 + 10π= **342 mA**

22. Define power and energy. Give the expression for electrical power and energy.

Power is the rate of doing work and its unit is Watt. The unit of electric power is defined in terms of the joule per second. One joule per second is the work done when one coulomb of electricity is moved through a potential difference of one volt in one second. **$P = EI = I^2R = E^2/R$ Watts.**

Energy is the product of power and time. If the power remains constant at Pduring the period of time t seconds, the energy equals Pt Watt-sec or Joules. **Energy $W = Pt = EIt = I^2Rt = E^2t/R$ J.**

23. Write down the expression of equivalent resistance for 'n' - number of resistors in parallel connection.

For 'n' resistors connected in parallel, the equivalent resistance is given by,

$$\frac{1}{\mathrm{Re}q} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \ldots\ldots\ldots + \frac{1}{Rn}$$

24. Write down the expression of equivalent resistance for 'n' – number of resistors in series connection.

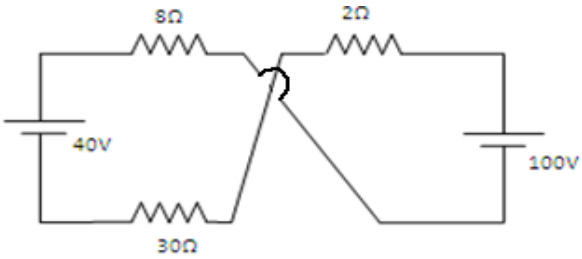
For 'n' resistors connected in series, the equivalent resistance is given by,

$Req=R_1+R_2+R_3+\ldots\ldots\ldots\ldots+R_n$

25. How much energy does a 100W electric bulb consume in two hours?

Power = Energy/Time => Energy = P*t = 100*2*3600 = 720000 = 720 KJ

26. Apply KVL and find the current in the circuit from 40V



By applying KVL,40-8I+100-2I-30I=0, Ans: I=5A

27. An electrical appliance consumes 2kWh in 30 mins at 120V. What is the current drawn by the appliance?

Energy, W = EIt ,I= $\frac{W}{Et} = \frac{1200 \text{ x } 3600}{120 \text{ X } 1800}$ = 20A

28. Calculate the equivalent resistance between the terminals "a" and "b" in Fig

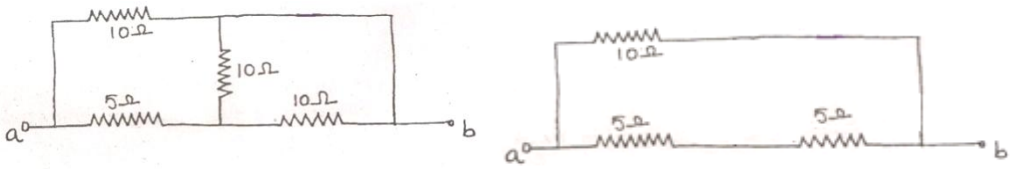


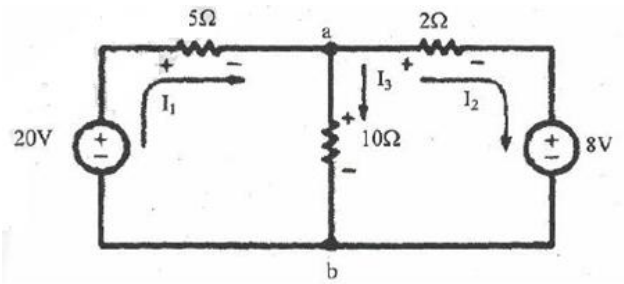
Fig. 1

Resistance between terminals 'a' and 'b' =$(10 \text{ X } 10)/(10 + 10)$ = 5Ω

29. Write briefly about resistance in a circuit.

The electrical resistance of a circuit component or device is defined as the ratio of the voltage applied to the electric current which flows through it: If the resistance is constant over a considerable range of voltage, then Ohm's law, I = V/R, can be used to predict the behavior of the material. The resistance is measured in units of ohms (Ω).

30. Obtain the current in each branch of the network shown below using Kirchoff's Current Law.



$5I_1 + 10(I_1 – I_2) = 20$

$10(I_2 – I_1) + 20I_2 = -8$

$I_1 = 48A$

$I_2 = 0.91A$

31. The resistance of two wires is 25Ω when connected in series and 6Ω when connected in parallel. Calculate the resistance of each wire.

$R_1+R_2=25\Omega$, $R_2=25-R_1$----------(1)

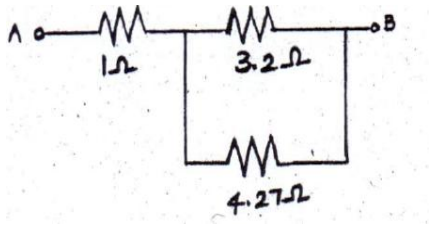
$R_1R_2/(R_1+R_2) = 6\Omega$,----------(2)

Substitueeqn(1) in eqn(2),

$R_1^2-25R_1+150=0$

$R_1=10\Omega, R_2=15\Omega$ (or)$R_1=15\Omega$, $R_2=10\Omega$

32. Find the equivalent resistance of the circuit shown in fig.



Equivalent resistance = $1+\frac{2\times27}{2+27}\ \Omega = 83\ \Omega$

33. Estimate the resultant resistance produced by the parallel connections of two resistors of 10Ω and 30Ω.

$$ResultantResistance = \frac{10 \text{ x } 30}{10 + 30} = 7.5\Omega$$

34. State Superposition theorem.

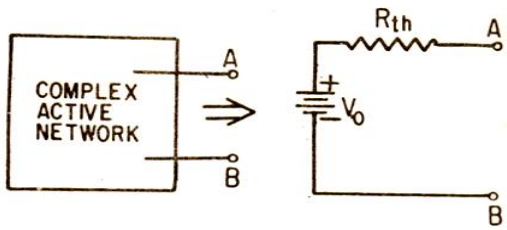
The superposition theorem states that in any linear bilateral network containing two or more sources, the response in any element is equal to algebraic sum of the responses caused by individual sources acting alone, while the other sources are non-operative; that is, while considering the effect of individual sources, other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuit across their terminals.

35. State Thevenin'stheorem .

Thevenin's theorem states that any circuit having a number of voltage sources, resistances and open output terminals can be replaced by a simple equivalent circuit consisting of a single voltage sourceV_{th} in series with a resistance(impedance)R_{th} (Z_{th}.).

Where$V_{th}$is equal to the open circuit voltage across the two terminals

R_{th} is equal to the equivalent resistance measured between the terminals with all energy sources are replaced by their internal resistance.

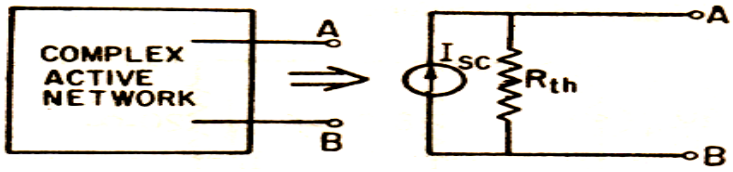


36.State Norton's theorem.

Norton's theorem states that any circuit with voltage sources, resistances (impedances) and open output terminals can be replaced by a single current sourceI_{sc} in parallel with single

resistanceR_{th}(impedanceZ_{th}.).Where$I_{sc}$is equal to the current passing through the short circuit output terminals

$R_{th}$is equal to the resistance seen into the output terminals with all energy sources are replaced by their internal resistance.



37. What is the limitation of superposition theorem.

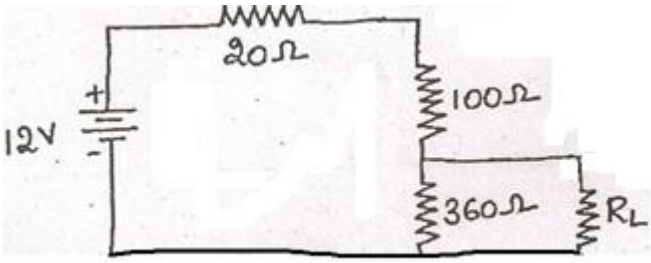
Super position theorem can be applied for finding the current through or voltage across a particular element in a linear bilateral circuit containing more than two sources. But this theorem cannot be used for the calculation of the power

38. List the applications of Thevenin's theorem.

It is useful for power system fault current calculation.

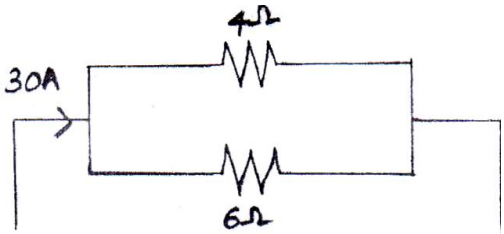
It is used in transmission line calculation.

39.Calculate the value of Norton's current (I_N)for the circuit shown in Fig.



$$I_N = \frac{12}{120} = 0.1A$$

40.Two resistors of 4 Ω and 6 Ω are connected in parallel. If the total current is 30A. Find the current through each resistor shown in below fig.



Current through 4Ω, $I_4 = I_T * \frac{R_6}{R_4 + R_6} = 30 \times \frac{6}{6+4} = 18$ A

Current through 6Ω, $I_6 = I_T * \frac{R_4}{R_4 + R_6} = 30 \times \frac{4}{6+4} = 12$ A

UNIT – II AC CIRCUITS

PART – A

1. What are the three types of power used in AC circuits?

Real or Active or True power P=EI cosθ ii) Reactive power Q=EI sinθ iii)Apparent power S=EI

2. Define Real power.

The actual power consumed in an AC circuits is called real power and P=EI cosθ

3. Define Reactive power.

The power consumed by the pure reactance (X_L or X_C) in an AC circuit is called reactive power. The unit is VAR and Q=EI sinθ

4. Define Apparent power and Power factor.

The Apparent power (in VA) is the product of the rms values of voltage and current.

$S = V_{rms}I_{rms}$. The Power factor is the cosine of the phase difference between voltage and current. It is also the cosine of the load impedance. **Power factor = cos φ .**The pf is lagging if the current lags voltage (inductive load) and is leading when the current leads voltage (capacitive load).

5. What is meant by Complex power?

Complex power (in VA) is the product of the rms voltage phasor and the complex conjugate of the rms current phasor. As a complex quantity, its real part is real power, P and its imaginary part is reactive ower, Q. and S = P + jQ

6. What are the advantages of 3 phase circuits over single phase circuits?

Generation, transmission and distribution of 3 phase power is cheaper, More efficient and Uniform torque production occurs

7. State the relationship between line voltage& phase voltage and line current & phase current of a 3 phase delta and star connected system.

For delta connected $V_{ph} = V_L$; $I_{ph}= I_L / \sqrt{3}$

For star connected $V_{ph}= V_L / \sqrt{3}$; $I_{ph}= I_L$

8. **Define Symmetrical System.**

It is possible in poly-phase system that magnitudes of different alternating voltage are different. But a three phase system in which the three voltages are of same magnitude and frequency and displaced from each other by 120° phase angle is defined as **symmetrical system.**

9. Give some method available for measuring three-phase power.

i.Single wattmeter method. ii. Two-wattmeter method. iii. Three-wattmeter method.

10. Explain the concept of balanced load.

The load is said to be balanced when magnitudes of all impedances Z_{ph1}, Z_{ph2} and Z_{ph3} are equal and the phase angles of all of them are equal and of same nature either all inductive or all capacitive or all resistive.

11. Define Phasor and Phase angle.

A sinusoidal wave form can be represented or in terms of a Phasor. A Phasor is a vector with definite magnitude and direction. From the Phasor the sinusoidal wave form can be reconstructed. Phase angle is the angular measurement that specifies the position of the alternating quantity relative to a reference.

12. Distinguish between unbalanced source and unbalanced load.

Unbalanced Source:

In unbalanced sources it will have negative sequence & zero sequence components whereas in a balanced source it has only positive sequence component.

Unbalanced Load:

If the individual load impedances are not identical then in general neither the line currents nor the line voltages at the load will have equal magnitudes. The phase sequence will affect both the magnitude and phase angle of current & voltage in the circuit.

13. Which type of connection of 3Φ system is preferred at the point of utilization? Why?

Three phase, 4 wire systems are used in utilization system so that either single phase or three phase load can be connected

14. While measuring power in a circuit by two wattmeter method, under what condition the two wattmeter reading will be equal and why?

When the power factor is unity or when the load is purely resistive, then the two wattmeter reading will be equal.

15. A star connected balanced load draw a current of 35A per phase when connected to a 440 V supply. Determine the apparent power.

Apparent power=$\sqrt{3}V_L I_L$=$\sqrt{3}$*440*35=**267 kVA**

16. Write the equation for the phasor difference between the potentials of the delta connected networks.

$V_{RY} = V_L \angle 0^O$ V

$V_{YB} = V_L \angle -120^O$ V

$V_{BR} = V_L \angle -240^O$ V

17. Three coils, each having a resistance of 20Ω and an inductive reactance of 15Ω are connected in star to a 400V, 3 phase and 50 Hz supply. Calculate (a) line current, (b) power factor and (c) power supplied.

Line current, $I_L = V_{ph}/ Z_{ph}$= 230.94 / 25 = 23 A

Power Factor, cos $\phi = R_{ph}/ Z_{ph}$= 20/25 = 0.8 lagging

Power Supplied, P = $\sqrt{3}\ V_L\ I_L \cos\phi$ = 51178W

18. A 3 phase 400 V is given to balanced star connected load of impedance 8+6j Ω.Calculate line current.

$I_L=I_{ph}$

$V_L = \frac{V_{ph}}{\sqrt{3}}$= 400/$\sqrt{3}$ = 230.9 V

$I=\frac{V_L}{Z}$ =230.9/(8+6j) = $23\angle -39^{o}$A

19. When a 3 Phase Supply System is Called Balanced Supply System?

If a three phase system has nominal voltage, frequency and phase shift of 120 degree with each other in all the phases, then the supply system is said to be balanced.

20. What are the components of a power system?

The components of power systems are Generators, Step up and Step down transformers, Loads and Transmission lines.

UNIT – III ELECTRICAL MACHINES

PART – A

1. State the principle of working of D.C. motor.

An electric motor is a machine which converts electrical energy into mechanical energy. Its action is based on principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's left hand rule.

2. What will happen to the speed of a D.C motor when its flux approaches zero?

For a constant back emf, flux is inversely proportional to the speed of motor. Soif flux drops to 0 theoretically speed will tend to infinity.

3. What is the function of commutator in a D.C motor?

To keep the torque on a DC motor from reversing every time the coil moves through the plane perpendicular to the magnetic field, a split-ring device called as commutator is used to reverse the current. To convert the D.C to A.C voltage, the commutator is used and it will performs the function of inverter.

4. Specify the methods used to control the speed of DC shunt motor for below and above the rated speed.

The speed of a D.C motor can be controlled by two ways,

1. Above the rated speed - Field control method,
2. Below the rated speed - Armature control method

5. List the different methods of speed control employed for dc series motor.

- Field diverter method Regrouping of field coils
- Tapped field control Armature resistance control
- Armature voltage control for single motor
- Series parallel control for multiple identical motors

6.What do you mean by "commutation' and commutation period?

The process by which current in the short circuited coil is reversed while it crossesthe magnetic neutral axis is called "commutation". The brief period during which coil remains short circuited is known as commutation period.

7. Name the starter used for D.C Motors.

The different starters used for the DC motors are,

1) Two point starter for D.C series motor. 2) Three point starter for D.C shunt motor 3) Four point starters for D.C. compound motors.

8. What are the various losses in a D.C. motor?

- Armature copper loss, Field copper loss, Core losses (hysteresis loss and eddy current loss)
- Mechanical losses (frictional loss and windage loss)

9. Explain the variation of hysteresis and eddy current losses with speed of a D.Cmotor.

Hysteresis loss is proportional to the speed of the motor and the eddy current loss is proportional to the square of the speed so long as excitation is constant.

11. Mention the effects of differential compounding and cumulatively compound on the performance of D.C compound motor?

Cumulative compound motor is used for variable loads and also occasionally for over loads. But differential compound motor is used for running constant speed from no load to full load.

12. What happen if the direction of current at the terminals of a D.C. series motor is reversed?

It does not reverse the direction of rotation of motor because current flows through the armature in the same direction as through the field.

13. Explainwhat happened when a D.C. motor is connected across A.C Supply Since on A.C. supply, the reactance offered the armature winding is much higher and it results in very less current, but the motor will run and it would not carry the same load as it would be operated with D.C. supply. There would be more sparking at the brushes. More eddy currents and hence more heat will be produced in iron parts**.**

14. What are the functions of holding coil and over load release coil in a 3-point starter?

- When the supply fails or gets disconnected, the holding coil demagnetizes and so release the starting arm which goes back to the OFF position by the spring action.
- Overload release coil is provided for the protection of the motor against the flow of excessive current due to over load. This coil is connected in series with the motor so carries full load current. When the motor is over loaded it draws heavy current and magnetizes the over load release coil to such an extent that it pulls

its armature upwards and so short circuit the no-volt release coil, so it demagnetizes and release the arm to the OFF position.

15. Explain how to reverse the direction of rotation of a D.C shunt motor.

The direction of rotation of a D.C. shunt motor can be reversed either by changing the direction of field current or armature current but, not both simultaneously.

16.State the principle of working of a transformer.

The working principle of transformer is based on faradays law of electromagnetic induction. The transformer consists of two inductive coils which are electrically separated but magnetically linked through a path of low reluctance. The two coils possess high mutual inductance. If one coil connected to a source of alternating voltage, an alternating flux is set up in the laminated core, most of which linked with the other coil in which it produces mutually induced emf. If the second coil is closed current flows in it and so electrical energy is transferred from the first coil to the second coil. It works on the principle of mutual induction.

17.**List the types of Transformer based on Construction.**

The transformers are broadly classified into two types,

1) Core type transformer
2) Shell type transformer.

18.State the merits and de-merits of Core and shell type Transformer. (Nov 2017) In core type construction mean length of the flux path is less and constructional difficulties are very less whereas the shell type construction requires special fabrication and construction features, more over the repair and maintenance under fault conditions is very in core type construction compared to shell type hence core type construction is preferred.

18.Define Transformation Ratio and classify the Transformer based on Transformation ratio.

Transformation ratio is defined as the ratio of number of turns in the secondary winding to number of turns in primary winding.

$$K = N2/N1 = E2/E1$$

Types : Step up transformer ($N1 > N2$) and Step down transformer ($N1 < N2$)

19.Define Voltage Regulation of a Transformer.

When a transformer is loaded with a constant primary voltage, the secondary voltage decreases for lagging power factor, and increases for leading power factor load because of its internal resistance and leakage reactance. The change in secondary terminal voltage from no load to full load expressed as a percentage of no load or full load voltage is termed as regulation.

% regulation down = (V2,0 - V2) x100 / V2,0

% regulation up = (V2,0-V2) x100 / V2

20.List the various losses in a Transformer and state the Condition for Maximum efficiency.

- Types of Losses are Core loss, Copper loss, Load (stray loss) and dielectric loss.
- Condition for maximum efficiency: Iron Loss = Copper Loss

21.State the methods to reduce Hysteresis and Eddy-current losses in a Transformer.

- To reduce hysteresis loss, core is made up of CRGO (Cold rolled Grain oriented)
- Eddy current loss is minimized by laminating the core

22.What happens when D.C Supply is given to a Transformer instead of A.C.?

When D.C Supply is given to a transformer the DC current saturates the magnetic core a large current flows through the windings, without inducing any e.m.f. This large current burns the windings of the transformer.

23.Name the methods of starting a synchronous motors

i. By an extra 3 phase induction motor. ii. By providing damper winding in pole shoes. iii. By operating the pilot exciter as a dc motor

24. Why a synchronous motor is called as constant speed motor?

Synchronous motor work on the principle of force developed due to the magnetic attraction established between the rotating magnetic field and the main pole feed. Since the speed of rotating magnetic field is directly proportional to frequency the motor operates at constant speed.

25.What are V and inverted V curves of synchronous motor ?

The variation of magnitude of line current with respect to the field current is called V curve. The variation of power factor with respect to the field current is called inverted V curve.

26. **What happens when the field current of a synchronous motor is increased beyond the normal value at constant input?**

Increase in emf causes the motor to have reactive current in the leading direction. The additional leading reactive current causes the magnitude of line current, accompanied by the decrease in power factor.

27. **Distinguish between synchronous phase modifier and synchronous condenser**

A synchronous motor used to change the power factor or power factor in the supply lines is called synchronous phase modifier. A synchronous motor operated at no load with over excitation condition to draw large leading reactive current and power is called a synchronous condenser.

28. **How the synchronous motor can be used as synchronous condenser?**

Synchronous motor is operated on over excitation so as to draw leading reactive current and power from the supply lines. This compensates the lagging current and power requirement of the load making the system power factor to become unity. The motor does the job of capacitors and hence called as synchronous condenser.

29.**Mention the methods of starting of 3-phase synchronous motor**A D.C motor coupled to the synchronous motor shaft.

i. A small induction motor coupled to its shaft

iii. Using damper windings as a squirrel cage induction motor.

30. What is meant by hunting of synchronous motor?

When the load applied to the synchronous motor is suddenly increased or decreased, the rotor oscillates about its synchronous position with respect to the stator field. This action is called hunting.

31. Write important differences between a 3-phase synchronous motor and a 3-phase induction motor.

i. Synchronous motor is a constant speed motor where as induction motor speed will decrease on load. ii. Synchronous motor requires A.C and D.C supplies where as induction motor requires only A.C supply. iii. Synchronous motor can be worked under various power factors such as lagging, leading and unity. But induction motor can be run with lagging power factor only.

32. What could be the reasons if a 3-phase synchronous motor fails to start?

It is usually due to the following reasons

i. Voltage may be too low. ii. Too much starting toad.

iii. Open circuit in one phase or short circuit. iv. Field excitation may be excessive.

33.State the principle of 3 phase IM?

While starting, rotor conductors are stationary and they cut the revolving magnetic field and so an emf is induced in them by electromagnetic induction. This induced emf produces a current if the circuit is closed. This current opposes the cause by Lenz's law and hence the rotor starts revolving in the same direction as that of the magnetic field.

35. Why an induction motor is called a rotating transformer'?

The rotor receives electric power in exactly the same way as the secondary of a two-winding transformer receiving its power from the primary. That is why an induction motor can be called as a rotating transformer i.e. one in which primary winding is stationary but the secondary is tree to rotate.

36. Why an induction motor will never run at its synchronous speed?

If the rotor runs at synchronous speed, then there would be no relative speed between the two; hence no rotor EMF, no rotor current and so no rotor torque to maintain rotation. That is why the rotor runs at a speed, which is always less than synchronous speed.

37.Why are the slots on the cage rotor of induction motor usually skewed?

It reduces humming and hence quite running of motor is achieved.

It reduces magnetic locking of the stator and rotor.

38. State the condition at which the starting torque developed in a slip-ring induction motor is maximum.

$R_2=X_2$; R_2 = rotor resistance; X_2 = Rotor reactance;

39. What are the effects of increasing rotor resistance on starting current and starting torque?

- The additional external resistance reduces the rotor current and hence the current drawn from the supply.
- It improves the starting torque developed by improving the power factor in high proportion to the decrease in rotor current.

40.What is slip of an induction motor?

The slip speed is defined as the ratio of relative speed to synchronous speed is expressed as

% slip = $(N_s - N)/N_s$ *100

41. What are the advantages of slip-ring IM over cage IM?

(i) Rotor circuit is accessible for external connection.

(ii) By adding external resistance to the rotor circuit the starting current is reduced with the added advantage of improving starting torque.

(iii) Additional speed control methods can be employed with the accessibility in the rotor circuit..

42. Name the tests to be conducted for predetermining the performance of 3-phase induction machine.

(a) No load test (b) Blocked rotor test

43. What are the information's obtained from no-load test in a 3-phase I M?

(i) No –load input current per phase, Io (ii) No load power factor and hence no load phase angle (iii) Iron and mechanical losses together (iv) Elements of equivalent circuit shunt branch

UNIT – IV ELECTRONIC DEVICES AND CIRCUITS

PART – A

1. Define doping?

The process of adding impurity to pure semiconductor is known as doping. As a result of it the characteristics of semiconductor is changed and hence the conductivity increases.

2. State mass action law.

Mass action law states that in a semiconductor the product of the number of holes and the number of electrons is constant and is independent of the amount of donor and acceptor impurity doping.

$$np = n_i^2$$

Where,n= free electron concentration

p= hole concentration; n_j = intrinsic concentration

3. Define the term the drift current.

If a steady electric field is applied across a semiconductor, it causes the free electrons to move towards the positive terminal and the holes move towards the negative terminal of the battery. This combined effect causes a current flow in the semiconductor. The current produced in this manner is known as drift current.

Drift current density due to electrons

$$J_n = qn\mu_n E$$

Drift current density due to holes

$$J_p = qp\mu_p E$$

J_n = Drift current density due to electrons, J_p= Drift current density due to holes

q = Charge of the carrier, μ_n = Mobility of electrons

μ_p = Mobility of holes, E = Applied electric field strength.

4. What is diffusion current? (Dec 2014)

In a semiconductor it is possible to have a non-uniform distribution of carriers. A concentration gradient exists if the number of either holes or electrons is greater in one region as compared to the rest of the region. The holes and electrons then tend to move from a region of higher concentration to lower concentration region.

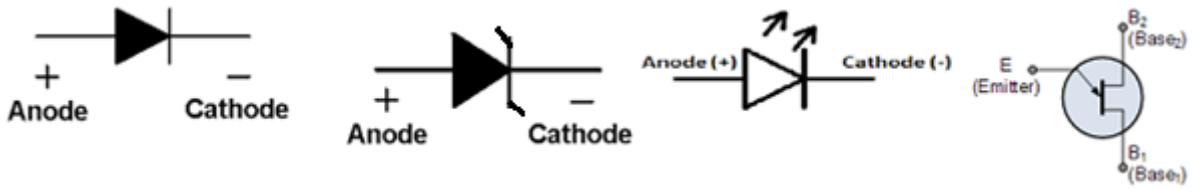
This process is known as diffusion and the electric current produced due this process is known as diffusion current.

5. What is a PN junction diode?

A PN junction diode is a two terminal device consisting of a PN junction formed either of Germanium or Silicon crystal. A PN junction is formed by diffusing P type material to one half side and N type material to other half side.

6. Draw the symbol of the following devices. (Nov 2015)

(a) PN Diode (b) Zener Diode (c) LED (d) UJT



7. What is Depletion region in a PN junction diode?

In a PN junction diode, the holes and the electrons combine to form electron-hole pair, leaving the uncovered acceptor and donor ions at the vicinity of the junction. The region where the charge carriers are depleted and has only immobile charges which are electrically charged is known as depletion region or space charge region.

8. Define barrier potential.

Potential barrier is defined as an electric potential that is established across the junction, during the initial diffusion of charge carriers at the junction, which restricts further movement of charge carriers across the junction.

9. Explain the terms knee voltage and breakdown voltage? (Nov 2010)

Knee voltage: The forward voltage at which the current through the PN junction starts increasing rapidly is known as knee voltage. It is also called as cut-in voltage or threshold voltage. Breakdown voltage: It is the reverse voltage of a PN junction diode at which the junction breaks down with sudden rise in the reverse current.

10. Write down and explain junction diode equation.

The equation which explains the forward and reverse characteristics of a semiconductor diode is known diode equation. The diode current is given by

$I = I_0\,(e^{v/\eta V_T} - 1)$ Where I_o = reverse saturation current

μ = 1 for Ge diodes, 2 for silicon diodes

V- External voltage; V_T = volt equivalent of temperature. = T/11,600

11. Define and explain Peak Inverse Voltage (PIV) (Nov 2010)

Peak inverse voltage is the maximum reverse voltage that can be applied to the PN junction without damage to the junction. If the reverse voltage across the junction exceeds to its peak inverse voltage, the junction may be destroyed due to excessive heat.

12. List the applications of PN junction diode. (May 2016)

1. Used as rectifier in DC power supplies.
2. Used as signal diodes in communication circuits.
3. Used in clipper and clamper circuits

13. Differentiate drift and diffusion current.

Drift current	Diffusion current
1. Developed due to potential gradient	Developed due to concentration gradient
2.Phenomenon found both in semiconductors and metals	Only in semiconductors
3. $J_n = qn\mu_n E$ $J_p = q\ p\ \mu_p E$	$J_n = q\ D_n dn / dx$ $J_p = q\ D_p dp / dx$

14. State the relationship between diode capacitance and the reverse bias voltage.

Transition capacitance $C_T = \frac{\in A}{W}$

The equation shows that the width of the depletion layer (W) is inversely proportional to the transition capacitance C_T. If the width of the depletion region increases, the capacitance decreases with increase in reverse voltage.

15.What are amplifiers? Write its uses.

An electronic device that is used to increase the magnitude of an electrical signal. Such a device used for the amplification of audio frequency signals in a radio.The amount of amplification provided by an amplifier is measured by its gain

UNIT – V MEASUREMENTS AND INSTRUMENTATIONIOI

PART - A

1. **What causes errors in moving ironinstruments?**

Temperature coefficient of spring, self-heating of coils in voltmeters, stray magnetic field, changes of reactance of working coils, changes of magnitudes of eddy currents cause errors in moving iron instruments.

2. State two sources of error in moving ironinstrument.

Hysteresis Error, Temperature error, Stray magnetic field, Frequency errors, Eddy currents

3. State the errors in PMMCinstruments.

Weakening of permanent magnets due to ageing and temperature effects, Weakening of springs due to aging and temperature effects, Change of resistance of moving coil with temperature.

4. Compare the merits of attraction and repulsion type MIinstruments?

	Attraction type	Repulsion type
Merts	a. Lower value ofinductance b. Accurate over a wider range of frequency and Greater possibility of using shunts withammeters.	a. Suitable for economical production. b. Uniformscale

5. **Why electro dynamometer type instrument is called transferinstruments?**

A transfer type instrument is one that may be calibrated with a d.c. source and then used without modification to measure a.c. This requires the transfer type instrument to have same accuracy for both

d.c. and a.c. which have the electrodynamometer instruments .

6. Define creeping in energy meter?

In some energy meters a slow but continuous rotation is obtained even when there is no current flowing through the current coil and only when pressure coil is energized. This is called creeping.

7. What are the causes of creeping in an energymeter?

Over compensation for friction, Excessive voltage across the potential coil, Vibrations, Stray magneticfields.

8. How is creep effect in energy meters avoided?

Two diametrically opposite holes are drilled in the disc of the energy meter. When one of the holes comes under the edge of the pole of the shunt magnet the rotation being limited to a maximum of half a resolution. In some cases a small piece of iron is attached to the edge of the disc.

9. What is ampere-hour andwatt-hour?

Ampere hour: the speed of rotation is proportional to ampere hour in ampere hour meter. Watt-hour: the speed of rotation is proportional to power in Watt-hour meter.

10. State two adjustments which are possible in induction type energymeter.

Preliminary light load adjustment, Full load unity factor adjustment, Lag adjustment with adjustable resistance & Lag adjustment with change of position of shading bands, Light load adjustment,Creepadjustment.

15. State any two applications of CT and of PT. (Dec2015)

a) In Protection circuits of power systems for the operation of over current, under voltage, earth faults and various other types of relays. b)Used for measurement purposes.

16. Define transformation ratio of an instrumenttransformer.

For a C.T: Transformation ratio (R) = primary winding current / rated secondary winding current. For a P.T: Transformation ratio (R) = primary winding voltage / secondary winding voltage.

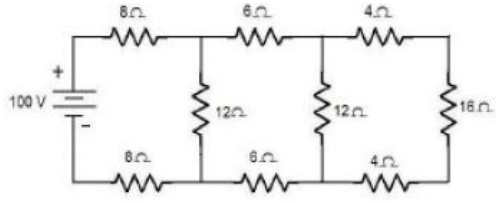
17. What is a difference between voltage transformer & currenttransformer?

The voltage transformer may be considered as parallel transformer with its secondary winding open circuit. Current transformer is a series transformer operates with its secondary short circuit conditions. The primary winding current in a C.T is independent of secondary winding circuit conditions while primary winding of P.T depends on the secondary circuit. In P.T full line voltage appears across its terminals whereas in C.T small voltage appears.

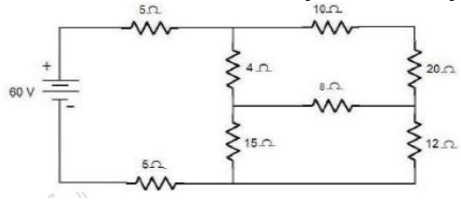
PART B & C QUESTIONS

UNIT I ELECTRICAL CIRCUITS

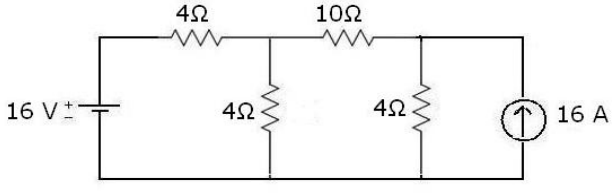
1. State and explain the Kirchoff's Law.
2. Calculate a) the equivalent resistances across the terminals of the supply, b) total current supplied by the source and c) power delivered to 16 ohm resistor in the circuit shown in figure.



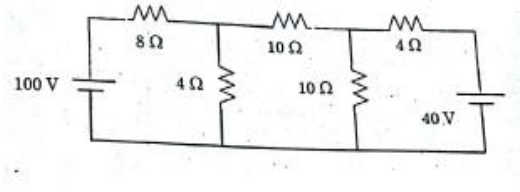
3. In the network shown below, find the current delivered by the battery using Kirchoff's law.



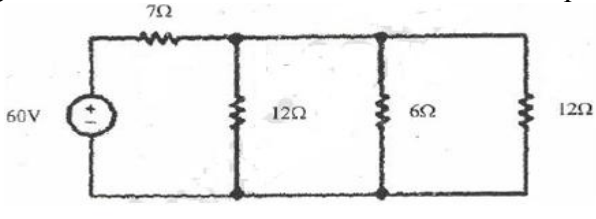
4.Calculate the current through the 10 Ω resistor using Superposition theorem.



5. Calculate the current flowing through the 10Ω resistor using Norton's theorem and also determine Norton's equivalent circuit.



6. Find the Thevenin's voltage and resistance and draw the Thevenin's equivalent circuit.



7. Explain the steps involved in power generation, transmission and distribution with neat diagrams.

UNIT II AC CIRCUITS

1. Derive the expression for power and power factor for RL, RC and RLC circuits. Draw the phasor diagram also.
2. Elaborate in detail about house wiring.
3. Explain industrial wiring with neat diagram.
4. A series circuit has R=10 , L=50mH, and C=100µF and is supplied with 200V,50Hz. Find (i) Impedance (ii) current (iii) power (iv) power factor (v) voltage drop across the each element.
5. Each phase of a 3-phase alternator produces a voltage of 6351V and can carry a current of 315A. Find the line voltage, maximum line and total kVA capacity of the alternator if it is
   i) Star connected ii) Delta connected
6. A series circuit has R = 10Ω, L=50mHand C=10µF and is supplied with 200V, 50Hz, Findi) Impedance ii) Current iii) Power iv) Power factorv) Voltage drop across the each element
7. A 400V is applied to three star connected identical impedances each consisting of a 40 resistance in series with 3 inductance reactance. Find (i) line current (ii) Total Power supplied.
8. Explain about three phase loads.
9. Derive an expression for current and voltage in star and delta connected loads.

UNIT III ELECTRICAL MACHINES

1. Explain the construction and operation of single phase transformer. And derive the emf equation of transformers.
2. Explain the construction and operation of DC motor.
3. Explain and derive the torque equation of DC motor.
4. Explain the construction and operation of DC generator.
5. Explain the types of excitation in DC motor and generator with their characteristics.
6. Derive the equation for induced EMF of a DC Machine
7. Discuss the three phase connections of transformer.
8. Explain the Construction and working of single phase Induction Motor.
9. Explain the different types of starting methods of single phase Induction Motor.
10. Explain the construction and working of three phase Induction Motor.
11. Explain the Construction and working of synchronous motor and also explain its starting methods.

UNIT IV ELECTRONIC DEVICES & CIRCUITS

1. With a neat diagram explain the working of a PN junction diode in forward bias and reverse bias and V-I characteristics.
2. Explain V-I characteristics of Zener diode.
3. Explain the operation and characteristics of BJT with neat diagrams.
4. Explain the operation and characteristics of BJT with CB,CC,CE configurations.
5. Discuss the operation of inverting and non inverting amplifier.
6. Explain the different types of ADC converters with neat diagrams .
7. Explain the different types of DAC converters with neat diagrams .

UNIT V MEASUREMENTS & INSTRUMENTATION

1. Explain the construction and working of LVDT with a neat sketch
2. Describe the construction and working of moving coil instrument with their torque equation.
3. With a neat diagram explain the construction and working of electrodynamometer type instruments. Also derive its torque equation.

4. Describe the construction and working of moving coil instrument with their torque equation.
5. Explain the multimeter with a neat sketch
6. Describe the construction and working of energy meter .
7. Discuss the operation of megger with neat diagram.
8. Describe the construction and operation of CT and PT.

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PART A QUESTIONS

UNIT-I ORGANIC REACTION MECHANISM

1. Write the Friedel Crafts reaction. **(Apl/May-2018)**
2. What happens when HBr is added on alkene in presence of peroxide? **(Apl/May-2018)**
3. Give a note on Beckmann rearrangement. **(May/Jun-2016)**
4. State the Markownikoff and anti-Markownikoff rule. **(May/Jun-2016)**
5. What are electrophilic reactions? **(Nov/Dec-2017)**
6. Write Perkin reaction. **(Nov/Dec-2017)**
7. Define the nucleophile with example. **(Nov/Dec-2016)**
8. State Anti-Markovnikov's rule with example. **(Nov/Dec-2016)**
9. Define an electrophile with example. **(Apl/May-2017)**
10. State Markovnikov's rule with example. **(Apl/May-2017)**
11. What are electrophiles?
12. Differentiate elctrophiles and nucleophiles reaction.
13. Define nucleophile wuth suitable example.
14. State peroxide effect.
15. Explain the anti-peroxide with suitable example.
16. Define halogenation with suitable example.
17. Write the difference between acylation and alkylation.
18. What do you mean by rearrangement reactions?
19. Define free radical with suitable example.
20. Classify organic reactions in detail.
21. Define substitution reaction with suitable example.
22. Explain addition reaction of alkane compounds.
23. Write the advantages of peroxide effect over Markovnikov's rule.
24. What do you mean by reaction intermediates?
25. What do you mean by reagents and classify with suitable examples?
26. What is hemolytic fission and heterolytic fission?
27. Define mesomeric effect.

UNIT-II CARBOHYDRATES

1. Write differences between starch and cellulose. **(Apl/May-2018)**
2. Write the structure of cellulose with at least two repeating units. **(Apl/May-2018)**
3. What is gun cotton? **(May/Jun-2016) (Nov/Dec-2017)**
4. What are polysaccharides? **(May/Jun-2016) (Nov/Dec-2017)**
5. How carbohydrates were classified? **(Nov/Dec-2016)**

6. Mention any two uses of gun-cotton. **(Nov/Dec-2016)**
7. What are epimers? Give example. **(Apl/May-2017)**
8. How carbohydrates are classified? **(Apl/May-2017)**
9. Define carbohydrates with suitable examples.
10. Write the formation of carbohydrates.
11. How do you classify monosaccharides?
12. What are enantiomers?
13. Explain D and L form of carbohydrates.
14. Mention the differences between D(+) Glucose and D (-) Glucose.
15. Explain about the Fisher projection of carbohydrates.
16. Define mutarotation.
17. Define the term anomers.
18. How the glucose can be prepared?
19. Write the reaction of glucosereacts with phenyhydrazine.
20. Write about Killiani Fisher synthesis.
21. Explain about degradation of glucoses.
22. Mention the uses of glucose.
23. Write any two reactions of fructose.
24. Define epimerization
25. Explain about haworth representation. Mention its advantages.
26. How do you prepare fructose from sucrose.
27. Write the oxidation reaction of fructose.

UNIT-III POLYNUCLEAR AROMATICS AND HETROCYCLES

1. Mention about the important properties and uses of naphthalene. **(Apl/May-2018)**
2. With reaction write about the preparation of thiophene. **(Apl/May-2018)**
3. Write the properties and uses of pyridine. **(May/Jun-2016)**
4. How are polynuclear aromatics classified? **(May/Jun-2016)**
5. Mention the uses of naphthalene. **(Nov/Dec-2017)**
6. Draw the structure of furan and its application. **(Nov/Dec-2017)**
7. Define a heterocyclic compound with example. **(Nov/Dec-2016) (Apl/May-2017)**
8. Complete the reaction Furan $+SO_3$ _Pyridine at 100^0c→ ? **(Nov/Dec-2016)**
9. Complete the reaction **(Apl/May-2017)**
   Naphthalene + HNO_3 H_2SO_4 **?**
10. What doyou mean by hetrocyclic compounds?
11. Mention the physical properties of naphthalene.
12. Classify heterocyclic compounds.
13. Write examples for five membered hetrocyclic compounds.
14. What are the physical properties of isoquinoline?
15. Write examples for six membered hetrocyclic compounds.
16. How the pyrrole can be prepared?
17. Write the uses of pyrrole.

18. Why the pyrrole undergoes electrphilic substitution only at 2 positions than 3 positions?
19. Pyrrole + HNO_3 $\longrightarrow$
20. Write the Friedel craft recation of pyridine.
21. Mention the physical properties of quinoline.
22. Write short notes on pyridine.
23. Write the physical properties of pyrrole.
24. Explain about electrophilic substitution reaction of pyridine.
25. Mention the structure of furan.
26. How the furan can be prepared?
27. Differentiate quinoline and isoquinoline.
28. Write the industrial method of pyridine preparation.
29. Why the pyridine is less basic than aliphatic amines?
30. Write the physical properties of furan.

UNIT-IV AMINO ACIDS AND PROTEINS

1. State about the general composition of proteins. **(Apl/May-2018)**
2. Justify, how are proteins hydrolysed? **(Apl/May-2018)**
3. Write the test for proteins. **(May/Jun-2016)**
4. Give a note on isoelectric point. **(May/Jun-2016)**
5. What are amino acids? Give two examples. **(Nov/Dec-2017)**
6. What is hydrolysis of proteins? **(Nov/Dec-2017)**
7. What are Zwitter ions? Explain with example. **(Nov/Dec-2016)**
8. Write the Biuret test for proteins. **(Nov/Dec-2016)**
9. What is meant by electrophoresis? **(Apl/May-2017)**
10. Write the causes for denaturation of proteins. **(Apl/May-2017)**
11. What do you mean by amino acids?
12. Write the zwitter – dipolar nature of amino acids?
13. Mention some examples of amino acids.
14. Define the optical activity.
15. Classify the methods of preparation of amino acids.
16. Write the properties of amino acids.
17. Mention the uses of glycine.
18. What are peptide linkages?
19. What are proteins?
20. How the proteins are classified?
21. Classify fibrous proteins.
22. Define globular proteins.
23. What do you mean by the isolation of proteins?
24. Write the general properties of proteins.
25. Write the importance of proteins.
26. How do you determine the protein content of foods?
27. Identify Millon's test.

28. What is ninhydrin test?
29. How will you distinguish between glycine and acetamide?
30. What happens when alanine is treated with nitrous acid?
31. What happens when glycine is heated?
32. What are α- amino acids?
33. Write short notes on isoelectric point of amino acids.

UNIT-V DRUGS AND DYES

1. Give a brief note on the properties of penicillin sulpha drugs. **(Apl/May-2018)**
2. Justify the role of chromophore in a synthetic dye. **(Apl/May-2018)**
3. What are chromophores? Give 2 examples. **(May/Jun-2016) (Apl/May-2017)**
4. How are drugs classified based on structure? **(May/Jun-2016)**
5. How are drugs classified? **(Nov/Dec-2017) (Apl/May-2017)**
6. Give the importance of chloroquine. **(Nov/Dec-2017)**
7. State the Witt's theory of colour. **(Nov/Dec-2016)**
8. List any two properties of drugs. **(Nov/Dec-2016)**
9. Define the term dyes.
10. State chromophore theory.
11. What is auxochrome theory?
12. What is modern theory of colors?
13. How the dyes are classified?
14. Write the uses of methyl orange.
15. Write about azo dyes.
16. What do you mean by the malachite green dyes?
17. Write shorts notes on phenopthalein.
18. Write about the indigo dyes.
19. How dyes classified by the methods of application?
20. What do you mean by the disperse dyes?
21. What do you mean by the ingrain dyes?
22. Write short notes on organic pigments.
23. What is food dyes?
24. What are purposes of food dyes?
25. Mention the safety concerns while using the food dyes.
26. Write short notes on mordant dyes?
27. Write the theory of color and constitution.

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PART B& PART C QUESTIONS

UNIT-I ORGANIC REACTION MECHANISM

1. Describe the mechanism of Riemer Tiemenn reaction and Beckmann rearrangements. (16) **(Apl/May-2018)**
2. Describe the mechanism of aldol condensation and Benzoin condensation (16) **(Apl/May-2018)**
3. With suitable example explain the mechanism in of Riemer Tiemann reaction ; (8) **(May/Jun-2016)**
4. Explain the Friedel Crafts reaction. (8) **(May/Jun-2016)**
5. Explain the mechanism of halogenation of alkenes. (8) **(May/Jun-2016)**
6. Write a note on Aldol condensation. (8) **(May/Jun-2016)**
7. Write Beckmann rearrangement reactions. (7) **(Nov/Dec-2017)**
8. Write aldol condensation reaction. (6) **(Nov/Dec-2017)**
9. Explain the allylic halogenation using N-Bromo Succinamide (NMS). (7) **(Nov/Dec-2017)**
10. Write about the thermal halogenation of alkene. (6) **(Nov/Dec-2017)**
11. Discuss the mechanism of Benzoin condensation. (7) **(Nov/Dec-2016)**
12. Explain the allylic halogenation using N-Bromo succinimide (NBS). (6) **(Nov/Dec-2016)**
13. Illustrate the mechanism of aldol-condensation. (7) **(Nov/Dec-2016)**
14. Discuss the mechanism of Beckmann rearrangement. (6) **(Nov/Dec-2016)**
15. Describe the mechanism of Riemer Tiemann reaction. **(7) (Apl/May-2017)**
16. Explain the allylic halogenation using N-Bromo Succinimide (6) (NBS). **(Apl/May-2017)**
17. Discuss the mechanism of Perkin's reaction.(7) **(Apl/May-2017)**
18. Describe the mechanism of aldol condensation. **(6) (Apl/May-2017)**
19. Predict the major product of Friedal-Craft alkylation of benzene using the following alkyl halides. . (5 x 3=15) **(Nov/Dec-2016)**
    (i) CH_3CH_2C! (ii) $CH_3CH_2CH_2Cl$ (iii) $CH_3CH_2CH(Cl)CH_3$
    (ii) $(CH_3)CCH_2Cl$(v) $(CH_3)_2CHCH_2Cl$.

UNIT-II CARBOHYDRATES

1. What is polysaccharide? Give example and explain with reaction about the formation of the selective polysaccharide. (3+13) **(Apl/May-2018)**
2. Explain with stepwise reaction about the conversion of cellulose into caboxy ~ methyl cellulose and gun cotton. (16) **(Apl/May-2018)**
3. Explain the structure of cellulose and its derivatives. Also discuss their properties. (16) **(May/Jun-2016)**.
4. What is starch? Discuss its structure and its industrial importance. (16) **(May/Jun-2016)**
5. Explain about the derivatives of cellulose. Carboxy methyl cellulose and gun cotton. (13) **(Nov/Dec-2017)**
6. Write about the structural aspects of cellulose. (13) **(Nov/Dec-2017)**
7. Explain the conversion of a pentose to hexose. (7) **(Nov/Dec-2016)**
8. How will you convert glucose to mannose? (6) **(Nov/Dec-2016)**
9. Describe the structural aspects of cellulose. (13) **(Nov/Dec-2016)**
10. Illustraté the Ruff degradation of a hexose.(7) **(Apl/May-2017)**
11. Write the conversion of glucose to fructose. (6) **(Apl/May-2017)**
12. Explain the structural aspects of cellulose.(13) **(Apl/May-2017)**
13. Explain in details the derivatives of cellulose.
14. How will be the effect of following?
    i. Aldopentose tc aldohexose. (4)
    ii. Aldohexose to aldopentose. (4)
    iii. Conversion of an aldose into ketose. (4)
    iv. Conversion of ketone into aldose. (3)
15. Give the open chain pyranose and furanose structures of glucose and fructose.
16. What happens when pyridines reacts with the following and give the name of the reaction.

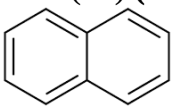
UNIT-III POLYNUCLEAR AROMATICS AND HETROCYCLES

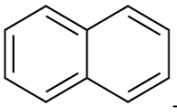
1. Classify the polynuclear aromatics. Explain with reaction about the preparation of one among them. (4+12) **(Apl/May-2018)**
2. Explain with reactions about the preparation of furan, pyrrole, quinoline and isoquinoline.(16) **(Apl/May-2018)**
3. Classify heterocyclic compounds based on their structures. (16) **(May/Jun-2016)**
4. Write the synthesis, properties and uses of Furan and thiophene.(16) **(May/Jun-2016)**
5. Write about the classification of polynuclear aromatics. (7) **(Nov/Dec-2017)**
6. Give the preparation of Naphthalene and its uses. (6) **(Nov/Dec-2017)**
7. Write about pyridine preparation and mention its uses. (6) **(Nov/Dec-2017)**
8. Give the synthesis of thiophene and furan. (7) **(Nov/Dec-2017)**
9. Discuss the preparation, properties and uses of naphthalene. (13) **(Nov/Dec-2016)**
10. Account for the reactivity and orientation in the electrophilic substitution of pyridine. (13) **(Nov/Dec-2016)**
11. Discuss the preparation, properties and uses of pyridine.(13) **(Apl/May-2017)**.

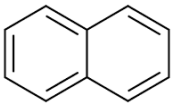
12. Account for the reactivity and orientation in the electrophilic substitution of furan. (13) **(Apl/May-2017)**
13. Give the products of the following reactions. **(Nov/Dec-2015)**
    (a) Benzene + CH_3Cl_ anhydrous $AlCl_3$>
    (b) Toluene + CH_3CH_2CI_ anhydrous $AlCl_3$>
14. Predict the major products in the following reactions.
    (a) 1propene + HBr ---------->
    (b) 1 propene + HBr __Peroxide__ —>
15. What are carbohydrates? How are they classified?
16. How is collodion prepared? Write its test.
17. Write the uses of naphthalene.

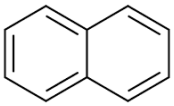
+ H_2 -----Ni---→

18. Write any two preparation methods for naphthalene. Predict the products of the following reactions. (16) **(Nov/Dec-2015)**

(i)  ___Na_____>
CH_3CH_2OH

(ii)  _Br_2_____>
CCl_4

(iii)  ___CH_3COCl / $AlCl_3$__>
CS_2 / -15^{0}C

(iv)  ___Conc H_2SO_4_____>
165^{0}C

UNIT-IV AMINO ACIDS AND PROTEINS

1. Explain the reaction mechanism of Strecker amino acid synthesis. (16) **(Apl/May-2018)**
2. Justify the classification of proteins based on the chemical composition. (16) **(Apl/May-2018)**
3. Discuss the properties of proteins. Explain their importance. (16) **(May/Jun-2016)**
4. Discuss the classification and properties of Aminoacids,(16) **(May/Jun-2016)**
5. Write about the classification of proteins and mention about the tests to identify the amino acids present in the proteins. (13) **(Nov/Dec-2017)**
6. Discuss about the general properties of proteins in detail. (13) **(Nov/Dec-2017)**

7. Write a note on denaturation of proteins with example. (5) **(Nov/Dec-2016)**
8. Describe the secondary structure of proteins. (13) **(Nov/Dec-2016)**
9. Predict the products when glycine reacts with (4x2=8) **(Apl/May-2017)**
   (1) Aq.NaOH
   (2) Aq.HCl
   (3) $NaNO_2$ +HCl and
   (4) $(CH_3CO)_2O$
11. Write any two tests for protein identification.(3+2) **(Apl/May-2017)**
12. Describe the secondary structure of proteins.(13) **(Apl/May-2017)**

UNIT-V DRUGS AND DYES

1. Elaborate on the chemical classification of drugs. (16) **(Apl/May-2018)**
2. How do you synthesize sulphanilamide and chloroquine? Explain with reactions. (16) **(Apl/May-2018)**
3. Write about the synthesis of DDT and methoxychlor. (10) **(May/Jun-2016)**
4. Write a note on Congo Red. (6) **(May/Jun-2016)**
5. Write about the theories of colour and constitution (10) **(May/Jun-2016)**
6. Write a note on chloramphenicol. (6) **(May/Jun-2016)**
7. How are the following drugs prepared? **(Nov/Dec-2017)**
   i. Penicillin sulpha drugs. (7)
   ii. Sulphanilamide. (6)
8. Brief about the classification of dyes. (7) **(Nov/Dec-2017)**
9. Write about the synthesis of methyl orange and malachite green. (6) **(Nov/Dec-2017)**
10. Brief about the classification of dyes. (7) **(Nov/Dec-2017)**
11. Write about the synthesis of methyl orange and malachite green. (6) **(Nov/Dec-2017)**
12. Write the synthesis of the drug chloramphenicol. (7) **(Nov/Dec-2016)**
13. Explain the preparation of Congo red. (6) **(Nov/Dec-2016)**
14. Describe the synthesis of DDT. (7) **(Nov/Dec-2016)**
15. Explain the preparation of malachite green. (6) **(Nov/Dec-2016)**
16. Write the synthesis of the drug sulphanilamide. (7) '**(Apl/May-2017)**
17. How will you prepare the dye congo red? (6) '**(Apl/May-2017)**
18. Describe the synthesis of methoxychlor.(7) **(Apl/May-2017)**
19. Explain the preparation of the dye methyl orange. (6)'**(Apl/May-2017)**
20. How the structure of a protein is established using 'C' and 'N' terminal analyses?(16) **(Nov/Dec-2015)**

21. Write the synthesis of sulphanilamide from Benzene, and chloroquine. (16) **(Nov/Dec-2015)**
22. Explain the classification of dyes based on structure and mode of dyeing.(16) **(Nov/Dec-2015)**

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