22203

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) State any two effects of force on a body.

b) Define self locking machine and state the condition for it.

c) State Varignon's theorem of moment.

d) State the types of beam with sketch (any two).

e) State two advantages of friction.

f) Define centre of gravity.

g) Write the reactions at support when simply supported beam of span 'L' carrying a point load 'W' at the centre.

Marks

2. Attempt any THREE of the following: **12**

a) Define solar and vector quantities giving two examples of each.

b) In a simple lifting machine, a load of 1400 N is lifted by 50 N effort. While load moves up by 0.2 m, the point of application of effort moves by 6 m. Find MA, VR and efficiency and ideal effort.

c) State law of machine and it's use. Also give expression for maximum MA and maximum efficiency of a lifting machine.

d) State four laws of friction.

3. Attempt any THREE of the following: **12**

a) Find the magnitude and direction of the resultant force as shown in Fig. No. 1.

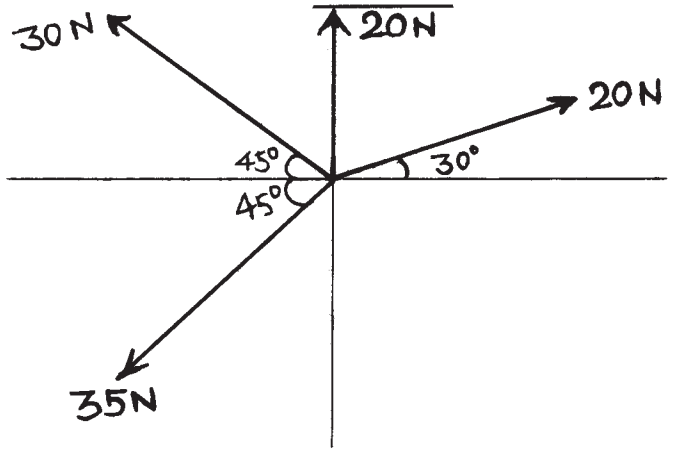


Fig. No. 1.

b) State four properties of couple.

c) In a differential axle and wheel, the diameter of the wheel is 40 cm and that of axles are 10 cm and 8 cm. If an effort of 50 N can lift a load of 1500 N, find the efficiency of the machine.

d) Certain machine follows the law P = (0.02 W + 14) N. When the load is lifted by 2 cm, the effort has to move 150 cm. State with reason, whether the machine is reversible or not.

Marks

4. Attempt any THREE of the following: **12**

a) A square ABCD of 2m side is subjected to forces as shown in Fig. No. 2. Find the magnitude, direction and position of the resultant with respect to A.

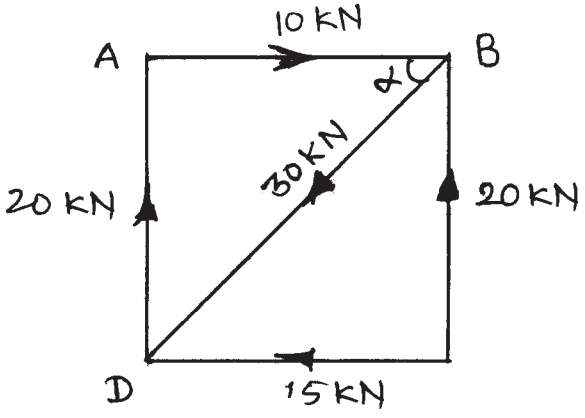


Fig. No. 2.

b) A cantilever is loaded as shown in Fig. No. 3. Find the support reaction.

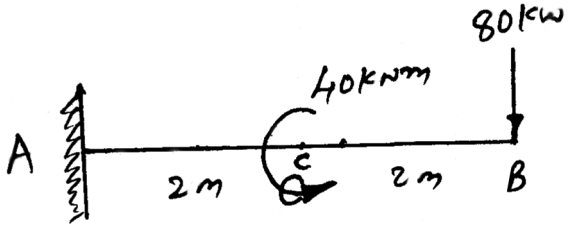


Fig. No. 3.

c) Calculate graphically the reactions of beam at the support as shown in Fig. No. 4.

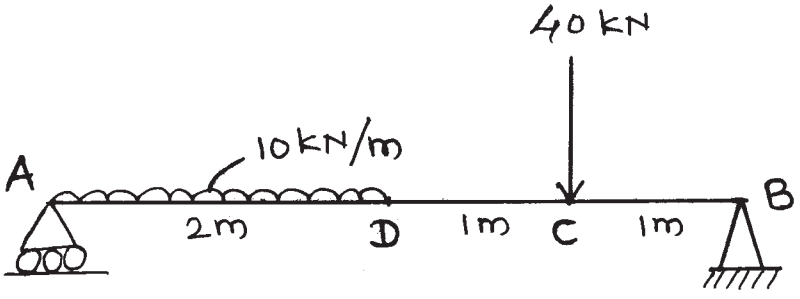


Fig. No. 4.

Marks

d) A body weighing 12 KN is lying on a horizontal plane for which $\mu = 0.70$ as shown in Fig. No. 5. Determine normal reaction, limiting force of friction, horizontal force required to move it and angle of friction.

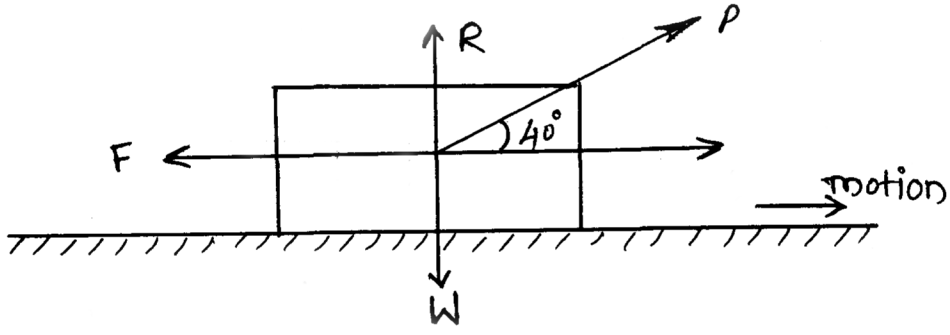


Fig. No. 5.

e) A body of weight 50 kN is hung by means of a string to the ceiling. Determine the pull required and tension in the string when string has an inclination 70° with the ceiling and pull is applied at 30° with the horizontal. Refer Fig. No. 6.

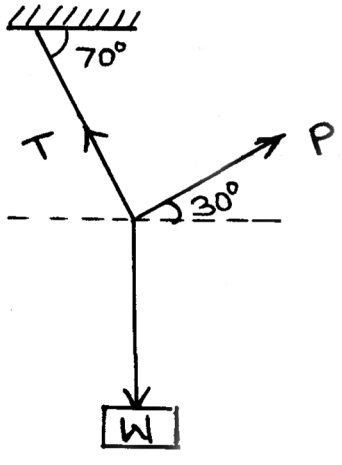


Fig. No. 6.

Marks

5. Attempt any TWO of the following: **12**

a) For a beam as shown in Fig. No. 7., calculate reaction at roller and hinge support by analytical method.

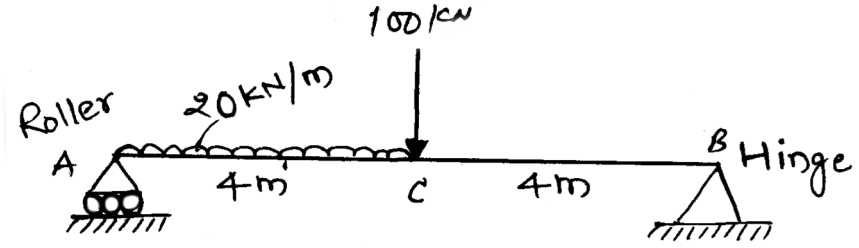


Fig. No. 7.

b) A body of weight 600 N is resting on a rough inclined plane at an angle of 40°. If coefficient of friction is 0.58, What force is required to prevent the body from falling down the plane.

c) Calculate the resultant and locate it's position w.r.t. point A for the force system shown in Fig. No. 8.

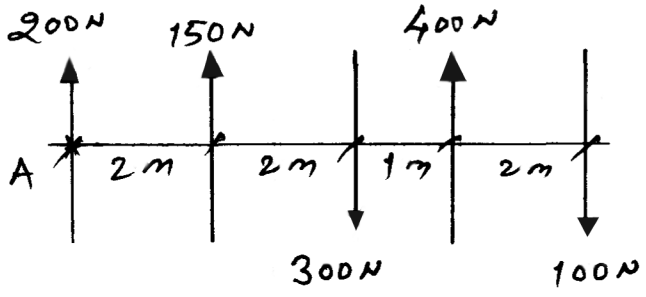


Fig. No. 8.

6. Attempt any TWO of the following: **12**

a) Find position of centroid for T-section as sown in Fig. No. 9.

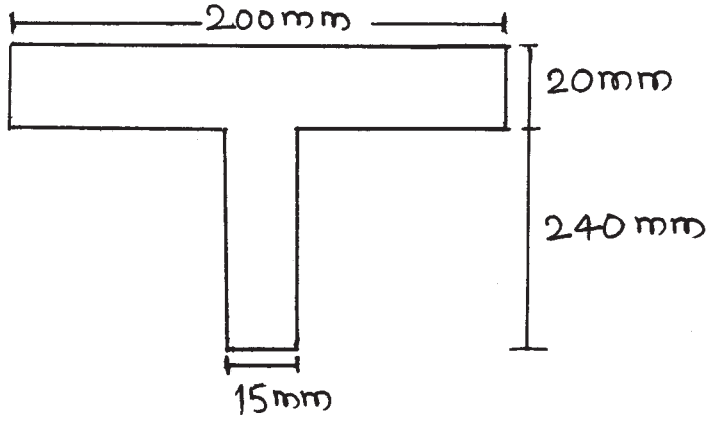


Fig. No. 9.

Marks

b) ABCD is a square plate of uniform thickness having each side of 300 mm. With A as centre and 300 mm as radius, a quarter circular portion ABD is removed as shown in Fig. No. 10. Locate the centroid of the remaining plate.

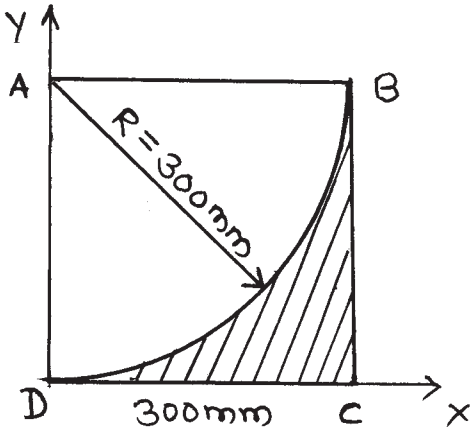


Fig. No. 10.

c) A solid sphere of 18 cm in diameter is placed on the top of a cylinder which is also 18 cm in diameter and 40 cm high such that their axes coincide. Find the centre of gravity of the combination. Refer Fig. No. 11.

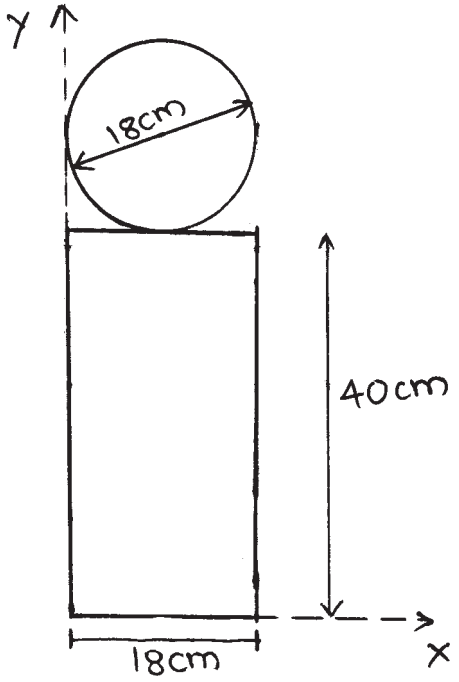


Fig. No. 11.

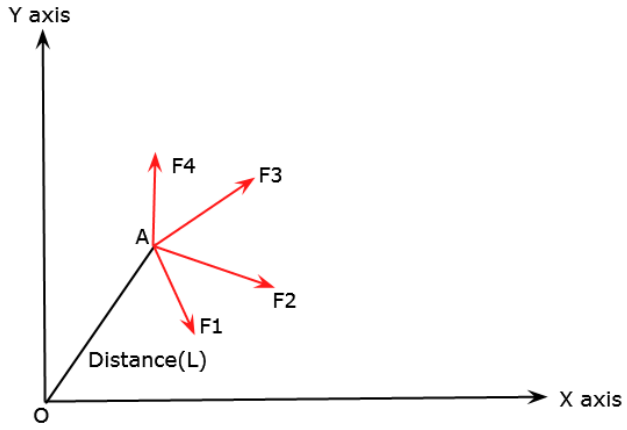
SUMMER – 2022 EXAMINATION

Subject Name: AME **Model Answer** **Subject Code:** 22203

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following** **Marks:10**	
		Effects of forces:	Any TWO
	a)	A force may produce the following effects in a body, on which it acts: 1. May change the State of rest or state of motion of a body 2. May accelerate or retard the motion of a body. 3. May enlarge or compress body or may change the shape of a body (This effect may be temporary or permanent) 4. May introduce internal stresses in the body.	1M 1M
	b)	**Non-reversible / irreversible or self-locking machine** When the machine is not capable of doing any work in the reversed direction, after the effort is removed, then the machine is called a non-reversible/irreversible or self-locking machine. The condition for a machine to be self-locking is that its efficiency should not be more than 50%. $\eta < 50\%$	1M 1M
	c)	**Varignon's Theorem** The algebraic sum of moments about a point of a system of concurrent forces is same as the moment of resultant of all these forces about the same point.	 1M

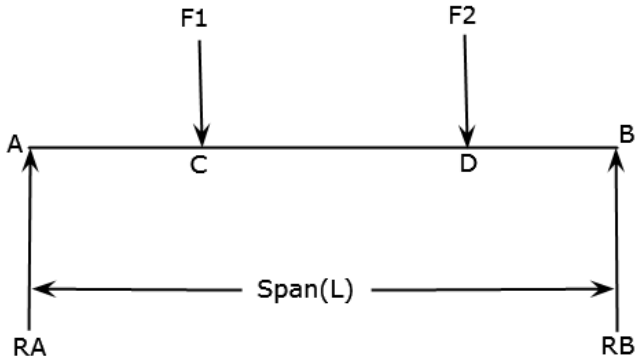


1M

Fig:Varignon's Theorem

d) **Types of Beams** Any TWO

1. Simple supported Beam: If the both the ends of the beam are simply supported then it is called as Simple Supported Beam.



1M

1M

Fig: Simple supported Beam

2. Cantilever Beam: If the beam is fixed at one end and free at other end, then it is called as cantilever Beam.

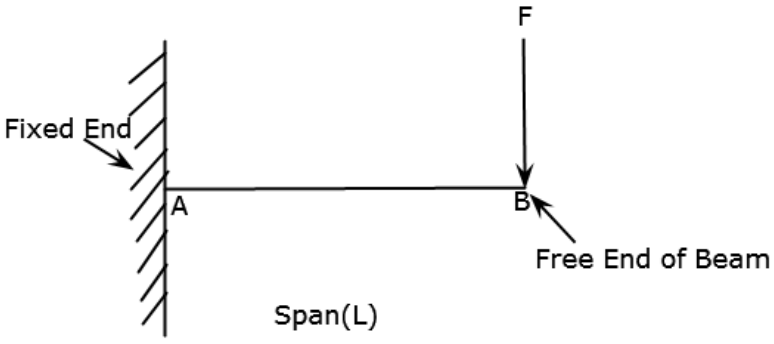


Fig : Cantilever Beam

3. Continuous Beam: If the beam is supported at more than two points then it is called as

continuous Beam.

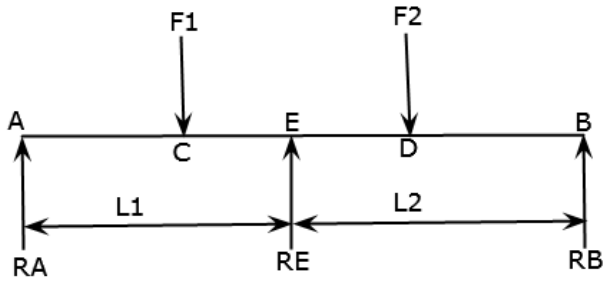


Fig: Continuous Beam

4. Overhanging Beam: If the end portion of the beam is extended beyond the support then it is called as overhanging Beam.

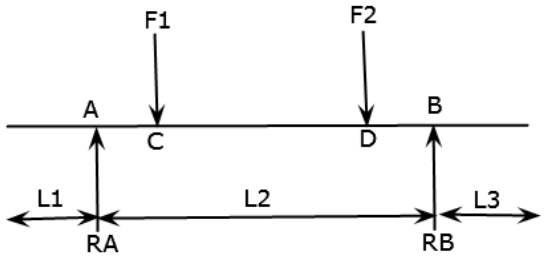


Fig: Overhanging Beam

5. Fixed Beam: If the both ends beam are fixed in the wall then it is called as fixed or constrained or built in Beam.

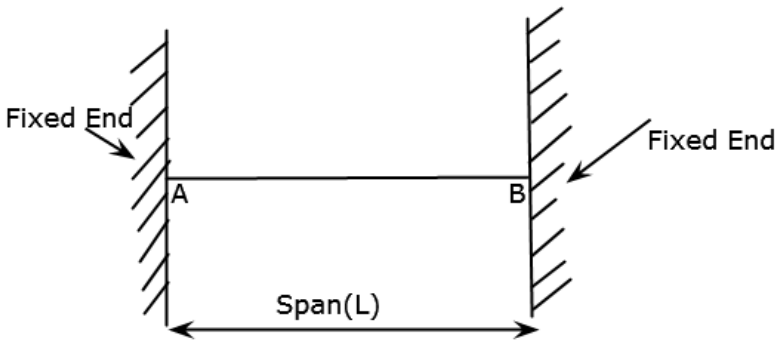


Fig: Fixed Beam.

e) **Advantages of friction:**

1. We can walk over the surface freely
2. We can easily hold the pen and write over the page.
3. Automobile braking system works under the principle of friction. 1M

4. Movement of vehicle with help of tyres over the road surface.

5. We can hold the object in our hand. 1M

f) **Center of Gravity (CG) :**

Center of gravity of a body is the point through which the whole weight of the body acts.

The Center of gravity of a body refers to a three-dimensional solid body or lamina. Because of solid body, we have to consider thickness. Hence we need to consider volume and/or weight of over solid body. The term Center of gravity is applicable to the Volume of a three-dimensional Solid body or lamina. Therefore, we can say that the Center of gravity is the point on a solid lamina or body, where the whole weight is concentrated. 1M

The center of gravity is applicable for a solid body such as solid cube, solid cylinder, solid cone, sphere for which we have to consider volume.

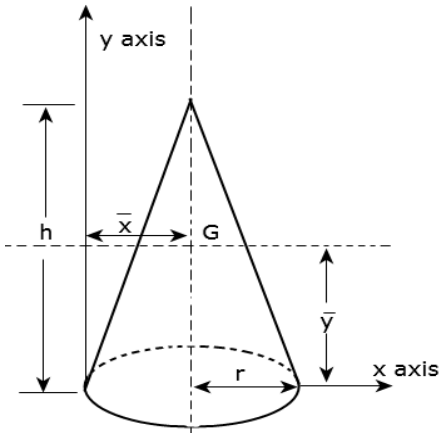
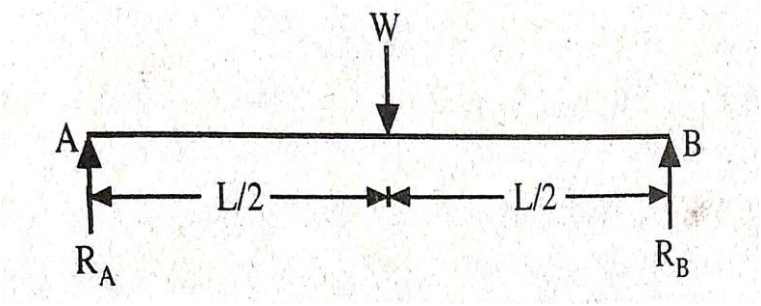


Fig:Solid Cone 1M

CG of the solid cone is $\bar{x} = r$ & $\bar{y} = \frac{h}{4}$

g) Simply supported beam with point load at the Centre.



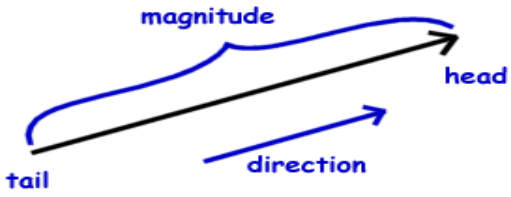
1M

Fig: Simply supported Beam with point load the Centre.

Reaction at support R_A and R_B.

$R_A = W/2$ ……Support Reaction at point A

$R_B = W/2$ ……. Support Reaction at point B

Q.2	a)	**Attempt any THREE of the following** **Marks:12** **1. Scalar and vector quantities** **1.1 Scalar quantity** A scalar quantity is one that has magnitude only. Examples: Mass, Length, volume, time, temperature and density.  **Fig: Scalar quantity** **1.2 Vector quantity** A vector quantity is one that has magnitude as well as direction. Examples: Force, displacement, velocity, acceleration and momentum etc.  **Fig: Vector quantity**	1M 2M 2M
	b)	**Given Data-:** Load lifted (W) =1400 N Effort value of (P) =50 N Distance moved by the effort (y) =6 m Distance moved by the load(x) = 0.2 m **To Find-:1.Mechncial Advantage (M.A)** **2. Velocity Ratio (V.R.)** **3. Efficiency** **4. Ideal Effort** **Solution** : We know that, **1.Mechanical Advantage (M.A)** $M.A = \frac{W}{P}$ M.A = 1400/50 M.A = 28 **2.Velocity ratio (V.R)**	1M

$$V.R = \frac{y}{x} = 6/0.2$$

$$V.R = 30$$

1M

3.Efficiency

$$\eta = \frac{M.A}{V.R} \times 100$$

$$\eta = (28/30) \times 100$$

1M

$$\eta = 93.33\%$$

4.Ideal Effort $P_i = \frac{W}{V.R}$

= 1400/30

= 46.66 N

c) **Law of a machine**

1M

The law of a machine gives the relationship between the effort applied and the load lifted. It states that ,for any machine if a graph is plotted between effort (P) and load lifted (W) it will be found that it follows a straight line relationship.

This graph does not pass through O but makes an intercept C on the y-axis which shows the effort is lost in overcoming frictional resistance only. The constant 'm' shows the slope of the graph.

2 M

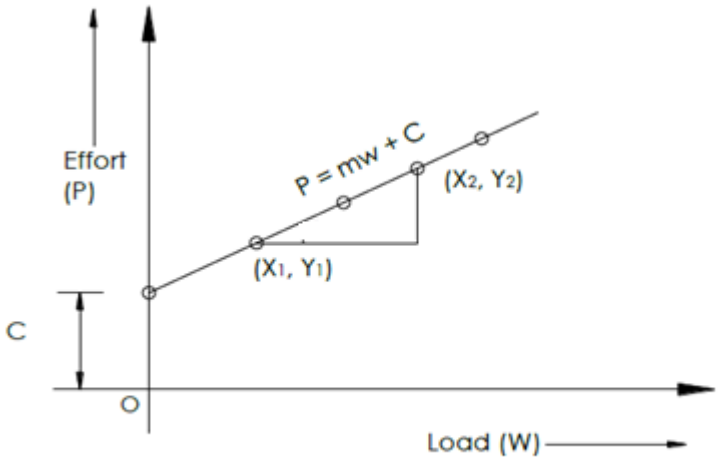


Fig.: Law of a machine

The equation P = mW + C is known as the law of machine. ……. (1)

Maximum Mechanical advantage and maximum Efficiency

We know that,

Mechanical advantage, $M.A = \frac{W}{P}$

$$M.A = \frac{W}{mW+C} \quad (\because P = mW+C)$$

$$= \frac{1}{m+\frac{C}{W}}$$

Value of W is extremely high hence, $\frac{C}{W}$ will tend to be zero and corresponding M.A will be maximum.

Mechanical advantage, $M.A_{max} = \frac{1}{m}$. …….....(2)

We know that, $M.A = \eta \times V.R.$

$$\eta = \frac{M.A}{V.R} = \frac{1}{m+\frac{C}{W}} \times \frac{1}{V.R}$$ 1M

The velocity ratio in any machine is fixed. Thus, η is directly proportional to M.A

For maximum M.A, the efficiency will also be Maximum

Maximum efficiency,

$$\eta_{max} = \frac{M.A\ max}{V.R}$$

$\eta_{max} = \frac{1}{m \times V.R}$…….... ……..(3) 1

d) **Laws of friction**

Following are the laws of friction (One mark for each)

1. The frictional force always acts in a direction, opposite to that in which the body is moving. 1M
2. The frictional force is independent on the area of the surfaces which is in contact. 1M
3. Frictional force depends on the roughness of surface. 1M
4. The ratio of frictional force to the normal reaction remains constant. 1M
5. The static friction is always greater than the dynamic friction.
6. In kinetic or dynamic friction for moderate speeds, the frictional force remains constant. But it decreases slightly with the increase of speed.

Q.3 **Attempt any <u>THREE</u> of the following** **Marks:12**

a) Find the magnitude and direction of the resultant force as shown in Fig. No. 1.

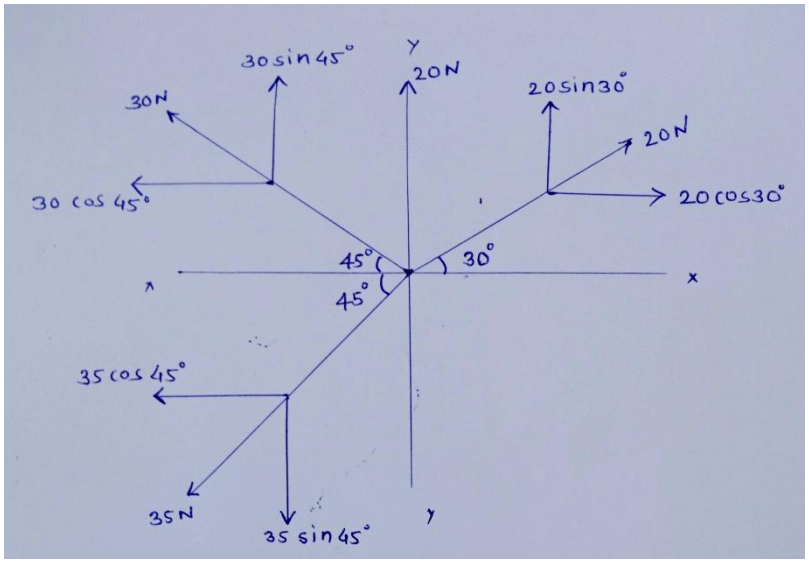
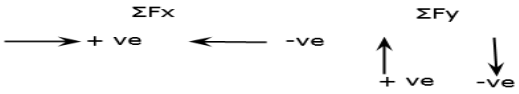


Fig.No.-01

Find **ΣFx** and **ΣFy**



Sign Convention for Resolution of Forces

Let us first find ΣFx

$$\Sigma Fx = 20\cos 30 - 30\cos 45 - 35\cos 45$$

$$\Sigma Fx = 17.32 - 21.21 - 24.74$$

$$\Sigma Fx = -28.63 \text{ N}$$ 1M

Find ΣFy

$$\Sigma Fy = 20 + 20\sin 30 + 30\sin 45 - 35\sin 45$$

$$\Sigma Fy = 20 + 10 + 21.21 - 24.74$$

$$\Sigma Fy = 26.46 \text{ N}$$

We have,

$$R = \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2}$$

$$R = \sqrt{(-28.63)^2 + (26.46)^2}$$

R= 38.98 N…… (Ans.)

Direction of Resultant $(\theta) = \tan^{-1}\left|\frac{\Sigma Fy}{\Sigma Fx}\right|$

$$\theta = \tan^{-1}\left|\frac{26.46}{-28.63}\right|$$ 1M

$\theta = \tan^{-1}|-0.9242|$

$\theta = 42.74^0$ **.....(Ans.)**

As ΣFx is negative and ΣFy is positive so Resultant (R) will be in second Quadrant making an angle of 42.74^0 with x-axis. 1M

b) State four properties of couple (any four- One mark each)

- The resultant of the forces of couple is zero
- The resultant of couple is equal to the product of one of the force and arm of couple.
- Moment of a couple about any point is constant.
- A couple can be balanced by only by another couple of equal and opposite movement.
- Two or more couple are said to be equal when they have same sense and moment.
- Any number of coplanar couples can be represented by a single couple, the moment of which is equal to the algebraic sum of the moment of all the couples.

4M

c) In a differential axle and wheel, the diameter of wheel is 40 cm and diameters of axle are 10 cm and 8 cm. If an effort of 50 N can lift a load of 1500 N, find the efficiency of the machine.

Solution.

Given Data-:

Diameter of Effort Wheel (D) = 40 cm
Diameter of bigger axle (d_1) = 10 cm
Diameter of smaller axle (d_2) = 8 cm
Effort (P) = 50 N
Load (W) = 1500 N

Calculate Velocity Ratio (V.R)

$$VR = \frac{2D}{d1-d2} = \frac{2 \times 40}{10-8} = 40$$

Calculate Mechanical Advantage (M.A.)

$$MA = \frac{W}{P} = \frac{1500}{50} = 30$$ 1M

We know that,

$$\eta = \frac{MA}{VR} \times 100$$ 1M

$\eta = \frac{30}{40} \times 100$

η = 75 % (Ans.) 2M

d) Certain machine follows the law P = (0.02W + 14) N.When the load is lifted by 2cm,the effort has to move 150cm.State with reason ,whether the machine is reversible or not.

Solution.

Distance moved by the effort, y = 150 cm

Distance moved by the load, x = 2 cm

The law machine is P = (0.02W + 14) N

So, m = 0.02

Mechanical advantage,

max M.A $= \frac{1}{m}$ 1M

$= \frac{1}{0.02}$

= 50

Calculate Velocity ratio (V.R)

V.R $= \frac{y}{x} = \frac{150}{2} =$ **75** 1M

Calculate Efficiency η % 1M

$\eta = \frac{max.M.A}{V.R} \times 100$

$\eta\,\% = \frac{50}{75} \times 100$

η = 66.67 % 1M

Here obtained efficiency is greater than 50 %, so given machine is reversible.

Q.4 a) **Attempt any <u>THREE</u> of the following** **Marks:12**

A square ABCD of 2m side is subjected to forces as shown in Fig. No. 2.Find the magnitude, direction and position of resultant with respect to A.

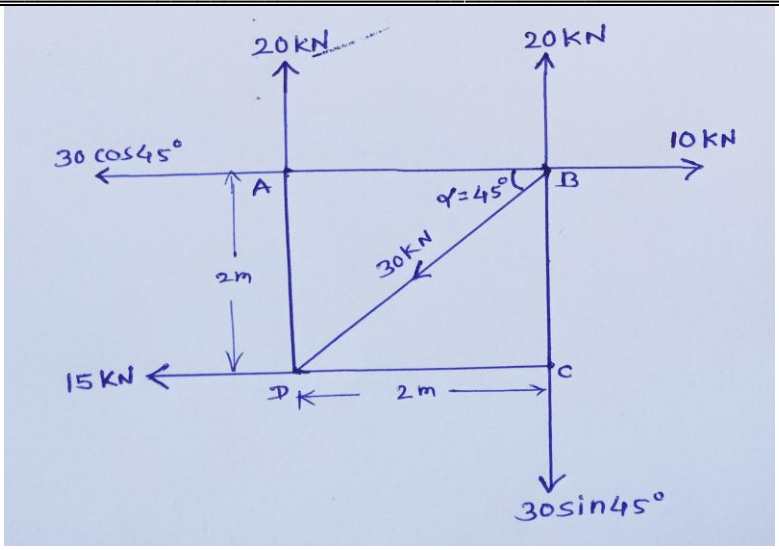


Fig.No.-02

1/2M

Let us first find ΣFx

$\Sigma Fx = 10 - 15 - 30\cos 45$

1/2M

$\Sigma Fx = -26.21$ N

1/2M

find ΣFy

$\Sigma Fy = 20 + 20 - 30\ \text{Sin}45$

$\Sigma Fy = 18.78$ N

$R=\sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2}$

$R=\sqrt{(-26.21)^2 + (18.78)^2}$

R= 32.24 N…… Magnitude of Resultant

Direction of Resultant $(\theta) = \tan^{-1}\left|\frac{\Sigma Fy}{\Sigma Fx}\right|$

1/2M

$\theta = \tan^{-1}\left|\frac{18.78}{-26.21}\right|$

$\theta = \tan^{-1}|-0.7165|$

$\theta = 35.62^0$**…….Direction of Resultant.**

1/2M

ΣFx is negative and **ΣFy** is positive so Resultant is lies in Second quadrant.

Taking moment about point A

$\Sigma M_A = -(20\times 2) + (15 \times 2) + (30\ \text{Sin}\ 45\times 2)$

= 32.42 kN-m

1/2M

Let x be the perpendicular distance of R from point A,

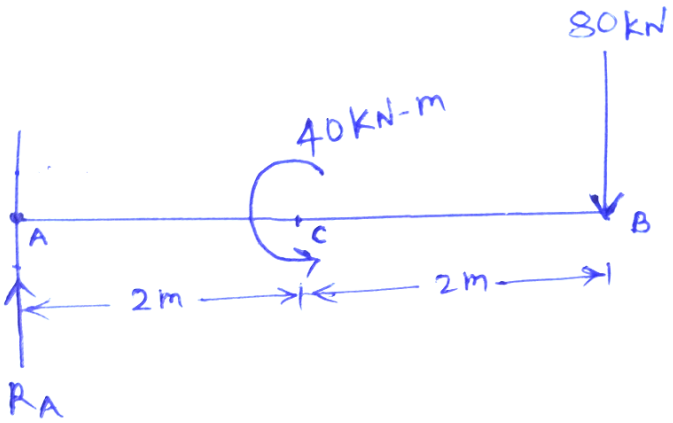
Using Varignons theorem of moment,

$\Sigma M_A = R \times x$ 1M

$32.42 = 32.34 \times x$

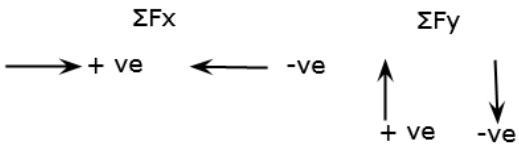
$x = 1.002$ ……Position of the resultant from point A.

b) A cantilever is loaded as shown in Fig. No. 3. Find the support reaction.



1M

Fig.No.-03



$\Sigma Fy = 0$ …….Conditions of equilibrium

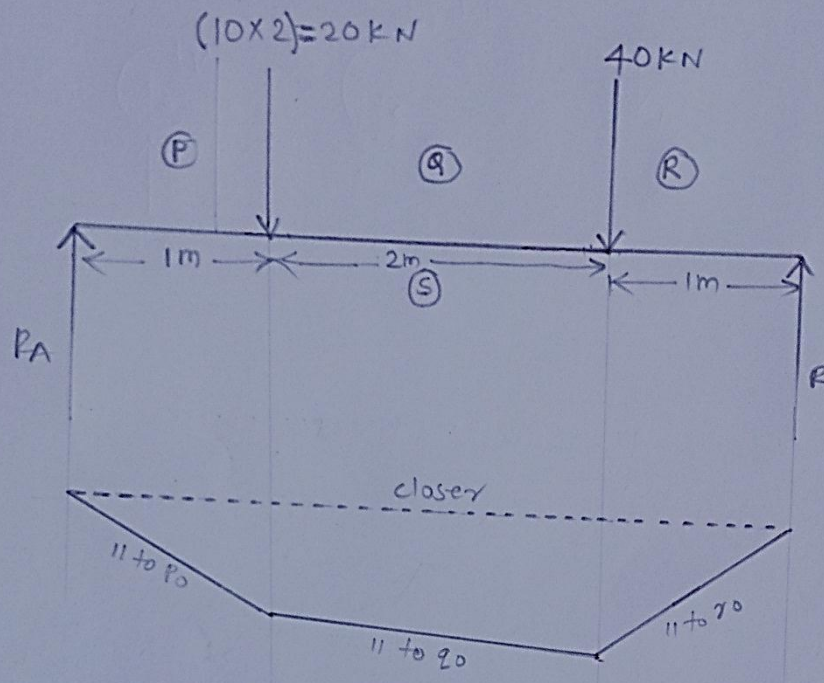
$R_A - 80 = 0$

R_A = 80 kN …….Support reaction

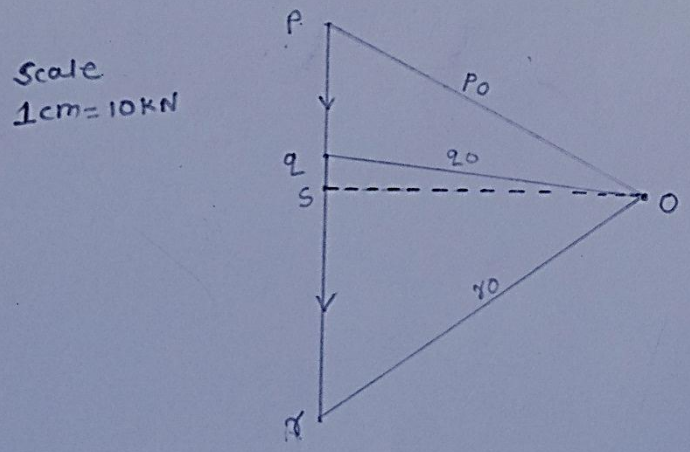
3M

c)

Q.4. ©



Space dia and funicular diagram.



Scale
1cm = 10KN

$R_A = l(PS) \times scale$
$= 2.5 \times 10$
$R_A = 25\ KN$

$R_B = l(SR) \times scale$
$= 3.5 \times 10$
$R_B = 35\ KN$

fig- Vector dia and funicular dia.

1M

1M

2M

d) A body of weight 12kN is lying on rough horizontal plane for which $\mu = 0.70$ as shown in Fig. No. 5. Determine normal reaction, limiting force of friction, horizontal force required to move it and angle of friction

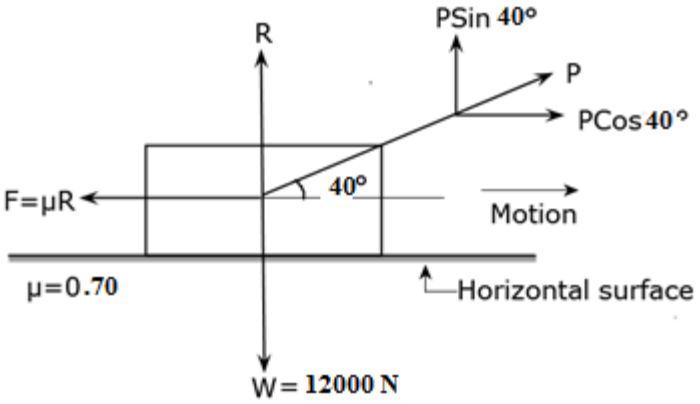
Given Data:

Weight of Body (W) = 12 kN = 12000 N

Coefficient of friction (μ) = 0.70

Applied force (P) = ?

Given Condition: Body Kept over Horizontal plane and force is inclined at an angle to Horizontal (θ) = 40°



1/2M

Fig. No.-5

For Limiting Equilibrium:

$\sum Fx = 0$ ⟶ +ve ⟵ –ve

∴ + P cos40° – F = 0

∴ P (0.766) – μR = 0

∴ P (0.766) = 0.70R

∴ $R = \frac{0.766P}{0.70}$

1/2M

∴ R = 1.094P ..... (i)

For Limiting Equilibrium:

$\sum Fy = 0$ ↑ +ve ↓ –ve

∴ P sin40°+ R – 12000 = 0

∴ 0.6427P + R – 12000 = 0

∴ R = 12000 – 0.6427P ..... (ii)

From Equation (i) and (ii), we get

$1.0943P = 12000 - 0.6427P$ 1/2M

$\therefore \quad 1.0943P + 0.6427P = 12000$

$\therefore \quad 1.737P = 12000$

$\therefore \quad P = \frac{12000}{1.737}$

$\therefore$ **P = 6908.46 N** or 69.08 kN .....Applied force

From equation (i)

$R = 1.094P$ 1M

$= 1.094 \times 6908.46$

R = 7557.85 N ……Normal reaction

Also,

$F = \mu R$

$= 0.70 \times 7557.85$

F = 5290.49 N ……Limiting force of friction 1/2M

We have,

$\tan\emptyset = \mu$

$\emptyset = \tan^{-1}|0.70|$

$\emptyset = 34.99^0$ ……Angle of friction 1/2M

e) A body of weight 50kN is hung by means of string to ceiling .Determine the pull required and tension in the string when string has an inclination 70^0 with the ceiling and pull is applied at 30^0 with horizontal. Refer Fig. No.6. 1/2M

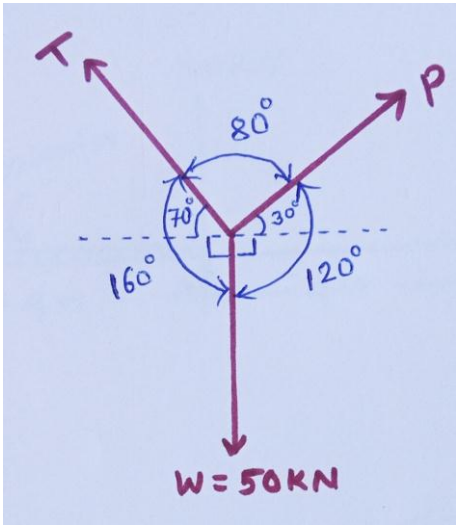


Fig.No.-06 1M

$\alpha = 160^0$, $\beta = 120^0$ and $\gamma = 80^0$

By using Lamis theorem,

$$\frac{P}{\sin\alpha} = \frac{T}{\sin\beta} = \frac{W}{\sin\gamma}$$

$$\frac{P}{\sin 160} = \frac{T}{\sin 120} = \frac{50}{\sin 80}$$ 1M

Consider,

$$\frac{P}{\sin 160} = \frac{50}{\sin 80}$$

$$P = \frac{50 \text{ Sin } 160}{\sin 80}$$

P =17.36 kN 1M

Consider,

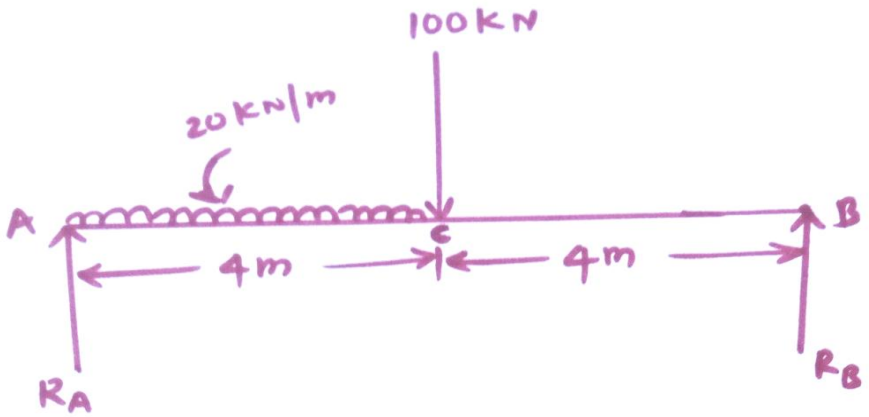
$$\frac{T}{\sin 120} = \frac{50}{\sin 80}$$

$$T = \frac{50 \text{ Sin } 120}{\sin 80}$$

T = 43.96 kN 1M

Q.5 a) **Attempt any <u>TWO</u> of the following** **Marks:12**

For the beam as shown in fig No. 7., calculate reaction at roller and hinge support by analytical method.



1M

Fig.No.-07

To find: Reaction at support R_A and R_B.

Now, $\Sigma Fy = 0$ (Sign Convention + ve ↑ –ve ↓)

$R_A + R_B - (20 \times 4) - 100 = 0$

$R_A + R_B - 180 = 0$ 1M

$R_A + R_B = 180$ ……equation (1)

Applying

$\Sigma M_A = 0$ ……. Taking moment about point A, 1M

Considering clockwise moment is positive and anticlockwise moment is negative.

$(20 \times 4 \times 2) + (100 \times 4) - (R_B \times 8) = 0$

$160 + 400 + -8R_B = 0$ 1M

$560 - 8R_B = 0$

$R_B = \frac{560}{8}$ 1M

R_B = 70 kN…….. Support Reaction at point B

By putting **R_B = 70 kN** in equation (1) we get,

RA + 70 =180

RA= 110kN……Support Reaction at point A 1M

b) A Body of weight 600N is resting on rough inclined plane at an angle of 40°. If the Coefficient of friction is 0.58. What force is required to prevent the body from falling down the plane?

Given Data:

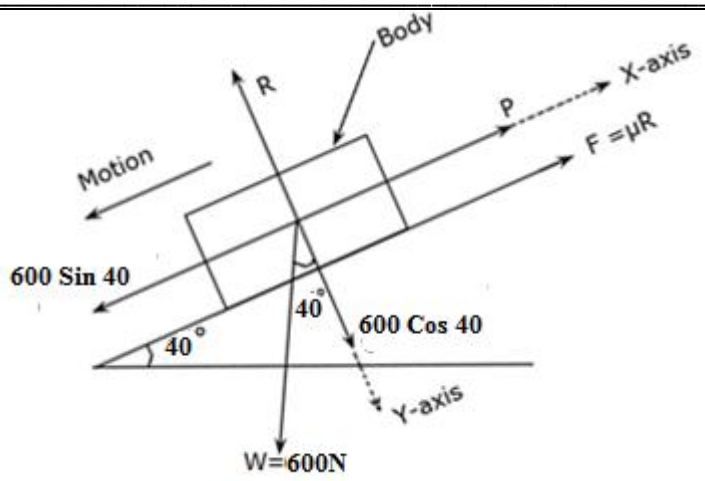
Weight of Body (W) = 600N

Coefficient of friction (μ) = 0.58

Angle made by inclined plane with horizontal $(\propto) = 40°$

Applied force (P) = ?

Given Condition: Body kept over inclined plane and force is parallel to plane.



1M

For Limiting Equilibrium:

$\sum Fy = 0$ ↑ +ve ↓ –ve 1M

∴ – 600 cos40° + R = 0

∴ – 459.62 + R = 0

∴ **R = 459.62 N** .....Normal Reaction 1M

But we know that,

∴ F = μR

∴ F = 0.58 × 459.62 1M

∴ **F = 266.57 N** .....Frictional force

For Limiting Equilibrium: 1M

$\sum Fx = 0$ ⟶ +ve ⟵ –ve

∴ – 600 sin40 + F + P = 0

∴ –385.67 + 266.57 + P = 0

∴ –119.10 + P = 0 1M

∴ **P = 119.10 N** .....Applied force

c) Calculate the resultant and locate its position w.r.t. point A for the force system as shown in Fig.No.8.

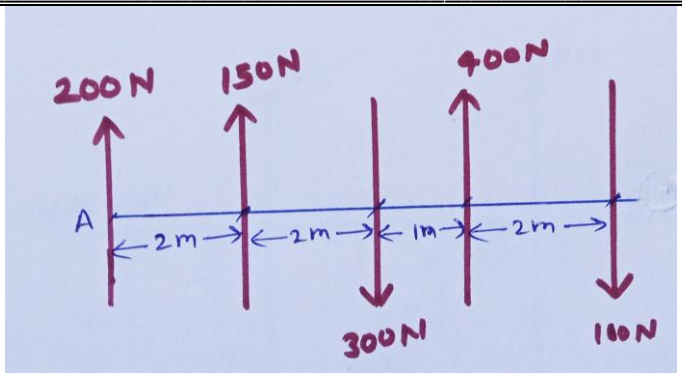


Fig.No-08

Taking moment about point A

ΣM_A = - (150 × 2) + (300× 4)−(400×5) + (100×7) **or** + (150 × 2) − (300 × 4) + (400× 5) - (100 × 7) 2M

= - 400 N-m = 400 N-m

= 400 N-m (anticlockwise moment)

ΣR = 200 +150−300 + 400−100

R = 350N

By using varignons theorem, 2M

$\Sigma M_A = R \times x$

$350 = 400 \times x$

$x = \frac{350}{400}$ 2M

x = 0.875 ……Position of the resultant from point A.

Q.6 a)

Attempt any TWO of the following **Marks:12**

Find the position of Centroid for T- section as shown in fig.No.-09

Solution:

1M

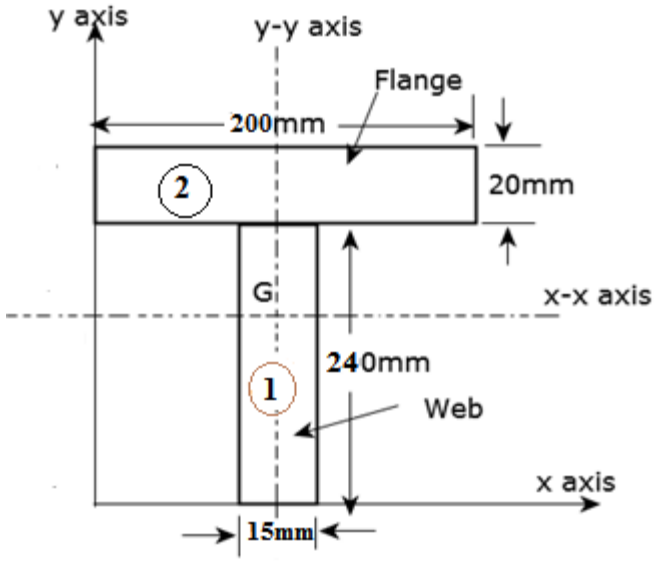


Fig.No.-09

1M

Area calculation:

1M

Area of web (A_1) = 240 × 15 = 3600 mm^2

Area of flange (A_2) = 200 × 20 = 4000 mm^2

Note: **Vertical** Part is called as **Web** or **Rib** and **Horizontal** Part is called as **Flange**.

To calculate centroidal position $\bar{x}$ from y -axis:

1M

Given T section is symmetrical to y-y Axis

$$\bar{x} = \frac{\text{Maximum length of Tsection}}{2}$$

$$\bar{x} = \frac{200}{2}$$

$\bar{x}$ = 100 mm (Ans.)

To calculate centroidal position of $\bar{y}$ from x- axis:

1M

$$y_1 = \frac{240}{2}$$

y_1 = 120 mm

$$y_2 = 240 + \frac{20}{2}$$

y_2 = 250 mm

$$\bar{y} = \frac{A1\ y1 + A2\ y2}{A1 + A2}$$

$\bar{y} = \frac{(3600 \times 120) + (4000 \times 250)}{(3600 + 4000)}$

$\bar{y}$ = 188.421 mm (Ans.)

Centroid ($\bar{x}$, $\bar{y}$) = (100mm, 188.421mm) (Ans.) 1M

b) ABCD is a square plate of uniform thickness having each side of 300 mm.With A as a center and 300mm as radius, a quarter circular portions ABD is removed as shown in Fig. No. 10. Locate the centroid of the remaining plate.

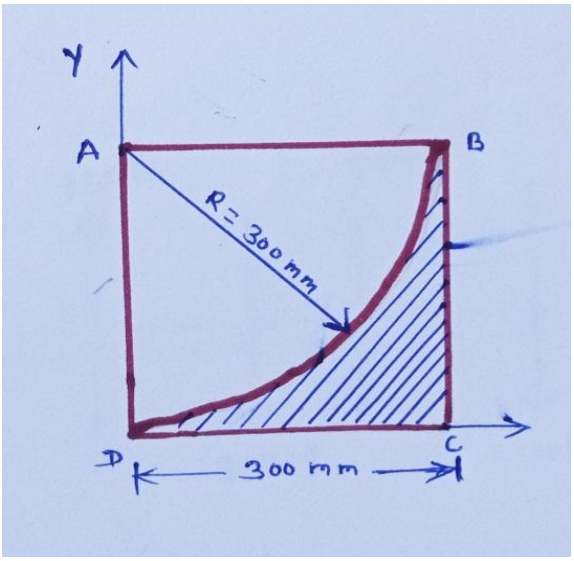


Fig.No.-'10

Area calculation:

Area of Square (A_1) = $(Side)^2 = (300)^2 = 90000$ mm^2 1M

Area of Quarter circle (A_2) = $\frac{1}{4} \times \pi r^2$

$= \frac{1}{4} \times \pi \times 300^2$

$= 70685.83$ mm^2

To calculate centroidal position $\bar{x}$ from y axis:

$x_1 = \frac{300}{2}$ 1M

$x_1 = 150$ mm

$x_2 = \frac{4r}{3\pi} = \frac{4 \times 300}{3\pi}$

$x_2 = 127.32$ mm 1M

$\bar{x} = \frac{A1\,x1 - A2\,x2}{A1 - A2}$

$$\bar{x} = \frac{(90000 \times 150) - (70685.83 \times 127.32)}{(90000 - 70685.83)}$$

$\bar{x}$ = 233 mm

To calculate centroidal position of $\bar{y}$ from x- axis:

$$y_1 = \frac{300}{2}$$

y_1 = 150mm

1M

$$y_2 = r - \frac{4r}{3\pi} = 300 - \frac{4 \times 300}{3\pi}$$

y_2 = 172.67 mm

$$\bar{y} = \frac{A1\ y1 - A2\ y2}{A1 - A2}$$

$$\bar{y} = \frac{(90000 \times 150) - (70685.83 \times 172.67)}{(90000 - 70685.83)}$$

1M

$\bar{y}$ = 67.032 mm

Centroid ($\bar{x}$, $\bar{y}$) = (233mm, 67.032mm) (Ans.)

c)

A solid sphere of 18cm in diameter 20 cm is placed on th6e top of a cylinder which is also 18cm in diameter and 40cm high such the their axis coincides. Find the center of gravity of combination. Refer Fig No-11

Solution:

Radius of solid cylinder (R) = $\frac{\text{Diameter of Solid cylinder}}{2} = \frac{18}{2} = 9$ cm

1M

Radius of solid sphere (r) = $\frac{\text{Diameter of Solid sphere}}{2} = \frac{18}{2} = 9$ cm

Height of solid cylinder (H) = 40 cm

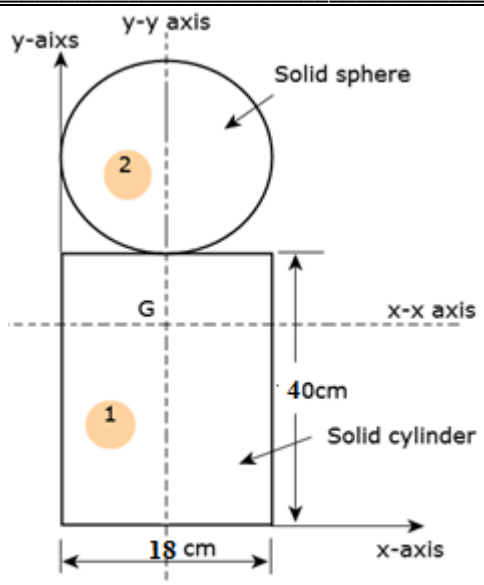


Fig.No-11

1M

Volume calculation:

Volume of Solid cylinder (V_1) = $\pi \times R^2 \times H$

$= \pi \times (9)^2 \times 40$

$= 10178.76 cm^3$

1M

Volume of solid sphere (V_2) = $\frac{4}{3} \times \pi \times r^3$

1M

$= \frac{4}{3} \pi \times (9)^3$

$= 3053.62 cm^3$

Center of gravity position of $\bar{x}$ from y- axis:

Given composite solid is symmetrical to y-y axis:

$$\bar{x} = \frac{\text{Maximum length of composite solid}}{2}$$

$$\bar{x} = \frac{18}{2}$$

$\bar{x}$ = 9 cm

Center of gravity position of $\bar{y}$ from x- axis:

1M

$$y_1 = \frac{h}{2}$$

$y_1 = \frac{40}{2}$

$y_1 = 20$ cm

$y_2 = 40 + r$

$y_2 = 40 + 9$

$y_2 = 49$ cm

1M

We know that,

$\bar{y} = \frac{V1\ y1 + V2\ y2}{V1 + V2}$

$\bar{y} = \frac{(10178.76 \times 20) + (3053.62 \times 49)}{(10178.76 + 3053.62}$

$\bar{y}$ = 26.69m

1M

Center of gravity G(**$\bar{x}$, $\bar{y}$) = (9 cm, 26.69m)**

22206

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Solve any FIVE of the following: **10**

a) If $f(x) = \log(\sin x)$. Then find $f(\pi/2)$.

b) Find Range of the function if $f(x) = 3x^2 - 5x - 7$ and $-3 \leq x < 2$.

c) If $y = \log_{10} x + 3^x$. Then find $\frac{dy}{dx}$.

d) Evaluate : $\int \frac{\sin x}{\cos^2 x}\, dx$

e) Find area under the curve $y = e^x$ from the ordinates $x = 0$ and $x = 1$.

f) Evaluate : $\int_0^{\pi/2} \sin x \cdot \cos x \cdot dx$

g) If the coin is tossed three times. Find the probability of getting exactly two Heads.

P.T.O.

Marks

2. Solve any THREE of the following: **12**

a) If $x^2 + y^2 = 4xy$, then find $\frac{dy}{dx}$ at $(2, -1)$.

b) If $x = 3at^2$, $y = 2at^3$. Find $\frac{dy}{dx}$.

c) The equation of the tangent at the point (2, 3) on the curve $y = ax^3 + b$ is $y = 4x - 5$. Find value of 'a' and 'b'.

d) Find Radius of curvature of the curve $y^2 = 4ax$ at $(a, 2a)$.

3. Solve any THREE of the following: **12**

a) A manufacture can sell x $(x \geq 0)$ items at price is of ₹ $(330 - x)$ each. The cost of producing x items in ₹ $x^2 + 10x + 12$. How many items must be sold so that his profit is maximum.

b) If $y = \tan^{-1}\left(\frac{2x}{1+15x^2}\right)$ find $\frac{dy}{dx}$.

c) Evaluate : $\int \frac{\sin(\sqrt{x})}{\sqrt{x}}\,dx$

d) If $y = (\sin x)^{\tan x}$. Find $\frac{dy}{dx}$.

4. Solve any THREE of the following: **12**

a) Evaluate : $\int \frac{1}{\sqrt{13-6x-x^2}}\,dx$

b) Evaluate : $\int \frac{1}{3+2\sin x}\,dx$

c) Evaluate : $\int e^x \cdot \sin 4x \cdot dx$

d) Evaluate : $\int \frac{\log x}{x \cdot (2 + \log x)\ (3 + \log x)}\,dx$

e) Evaluate : $\int_0^5 \frac{\sqrt{9-x}}{\sqrt{9-x}+\sqrt{x+4}}\,dx$

Marks

5. Solve any TWO of the following: **12**

a) Find the area bounded by the parabola $y^2 = 4x$ and $x^2 = 4y$.

b) i) Solve : $x^2 y\,dx - (x^3 + y^3)\,dy = 0$

ii) From a differential equation of $y = a \cos 4x + b \sin 4x$.

c) Acceleration of a moving particle at the end of 't' second. From the start of it's motion is $(5 - 2t)$ m/s^2. Find it's velocity at the end of 3 seconds and distance travelled by it during the period. If it's intial velocity is 4 m/s.

6. Solve any TWO of the following: **12**

a) If 20% of the bolts produces by a machine are defective. Find the probability that out of 4 bolts drawn.

i) One is defective

ii) at most two are defective

b) If the probability of a bad reaction from the certain injection is 0.001, determine the chance that out of 2000 individuals more than two will get a bad reaction. (Given $e^2 = 7.4$)

c) In a sample of 1000 cases the mean of certain test is 14 and S.D is 2.5. Assuming the distribution to be normal. Find

i) How many students score between 12 and 15?

ii) How many students score above 18?

[Given : A(0.8) = 0.2881, A(0.4) = 0.1554, A(1.6) = 0.4452]

SUMMER – 2022 EXAMINATION

Subject Name: Applied Mathematics **Model Answer** **Subject Code: 22206**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Solve any FIVE of the following:**	**10**
	a)	If $f(x)=\log(\sin x)$. Then find $f\left(\frac{\pi}{2}\right)$	**02**
	Ans	$f(x)=\log(\sin x)$	
		$\therefore f\left(\frac{\pi}{2}\right)=\log\left(\sin\frac{\pi}{2}\right)$	1
		$\therefore f\left(\frac{\pi}{2}\right)=0$	1
	b)	Find range of the function if $f(x)=3x^2-5x-7$ and $-3\le x<2$.	**02**
	Ans	$f(x)=3x^2-5x-7, -3\le x<2$	
		$\therefore f(-3)=3(-3)^2-5(-3)-7=35$	½
		$f(2)=3(2)^2-5(2)-7=-5$	½
		$\therefore$ Range of function $=-5\le f(x)<35$	1

SUMMER – 2022 EXAMINATION

Subject Name: Applied Mathematics **Model Answer** **Subject Code: 22206**

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	c) Ans	Find $\frac{dy}{dx}$, If $y = \log_{10} x + 3^x$	
		$y = \log_{10} x + 3^x$	½
		$\therefore y = \frac{\log x}{\log 10} + 3^x$	
		$\therefore \frac{dy}{dx} = \frac{1}{\log 10}\frac{1}{x} + 3^x \log 3$	1½
		$\therefore \frac{dy}{dx} = \frac{1}{x\log 10} + 3^x \log 3$	
		---	
	d) Ans	Evaluate: $\int \frac{\sin x}{\cos^2 x}\, dx$	**02**
		$\int \frac{\sin x}{\cos^2 x}\, dx = \int \frac{\sin x}{\cos x}.\frac{1}{\cos x} dx$	½
		$= \int \sec x \tan x\, dx$	½
		$= \sec x + c$	1
		OR	
		$\int \frac{\sin x}{\cos^2 x}\, dx$	
		Put $\cos x = t$	½
		$\therefore \sin x dx = -dt$	
		$\therefore \int \frac{1}{t^2}\, (-dt)$	
		$= -\left(-\frac{1}{t}\right) + c$	1
		$= \frac{1}{\cos x} + c$	½
		$= \sec x + c$	
		---	
	e) Ans	Find the area under the curve $y = e^x$ from the ordinates $x = 0$ and $x = 1$.	**02**
		Area $A = \int_a^b y\, dx$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	e)	$= \int_0^1 e^x dx$	½
		$= \left[e^x \right]_0^1$	1
		$= \left(e^1 - e^0 \right)$	
		$= e - 1$	½
		or 1.718	
		---	
	f)	Evaluate: $\int_0^{\frac{\pi}{2}} \sin x \cos x dx$	**02**
	Ans	$\int_0^{\frac{\pi}{2}} \sin x \cos x dx$	
		$= \frac{1}{2} \int_0^{\frac{\pi}{2}} \sin 2x dx$	½
		$= -\frac{1}{2} \left[\frac{\cos 2x}{2} \right]_0^{\frac{\pi}{2}}$	1
		$= -\frac{1}{2} \left[\frac{\cos \pi}{2} - \frac{\cos 0}{2} \right]$	
		$= -\frac{1}{2} \left[\frac{-1}{2} - \frac{1}{2} \right]$	
		$= \frac{1}{2}$	½
		OR	
		$\int_0^{\frac{\pi}{2}} \sin x \cos x dx$	
		Put $\sin x = t$, $\therefore \cos x dx = dt$	
		$\therefore \quad x = 0,\ x = \frac{\pi}{2}$	
		$t = 0,\ t = 1$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	f)	$\therefore \int_0^1 tdt$	
		$= \left[\frac{t^2}{2}\right]_0^1$	1
		$= \frac{1}{2} - 0$	
		$= \frac{1}{2}$	½
	g)	If the coin is tossed three times .Find the probability of getting exactly two heads.	**02**
	Ans	$S = \{HHH, HHT, HTH, THH, TTH, THT, HTT, TTT\}$	
		$\therefore n(S) = 8$	½
		getting exactly two heads	
		$\therefore A = \{HHT, HTH, THH\}$	
		$\therefore n(A) = 3$	½
		$\therefore P(A) = \frac{3}{8} or\ 0.375$	1
		OR	
		$n = 3, p = \frac{1}{2}, q = \frac{1}{2}, r = 2$	
		$p(r) = nc_r (p)^r (q)^{n-r}$	
		$p(1) = 3c_2 \left(\frac{1}{2}\right)^2 \left(\frac{1}{2}\right)^{3-2}$	1
		$= \frac{3}{8}\ or\ 0.375$	1
2.		**Solve any THREE of the following:**	**12**
	a)	If $x^2 + y^2 = 4xy$, then find $\frac{dy}{dx}$ at $(2,-1)$	**04**
	Ans	$x^2 + y^2 = 4xy$	
		$\therefore 2x + 2y\frac{dy}{dx} = 4\left(x\frac{dy}{dx} + y.1\right)$	1

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	a)	$\therefore 2x+2y\frac{dy}{dx}=4x\frac{dy}{dx}+4y$	
		$\therefore (2y-4x)\frac{dy}{dx}=4y-2x$	1
		$\therefore \frac{dy}{dx}=\frac{4y-2x}{2y-4x}$	
		$\therefore \frac{dy}{dx}=\frac{2y-x}{y-2x}$	1
		At $(2,-1)$	
		$\therefore \frac{dy}{dx}=\frac{2(-1)-2}{-1-2(2)}$	
		$\therefore \frac{dy}{dx}=\frac{4}{5}$	1
		---	
	b)	If $x=3at^2, y=2at^3$. Find $\frac{dy}{dx}$	**04**
	Ans	$x=3at^2$	
		$\therefore \frac{dx}{dt}=6at$	1
		$y=2at^3$	
		$\therefore \frac{dy}{dt}=6at^2$	1
		$\frac{dy}{dx}=\frac{\frac{dy}{dt}}{\frac{dx}{dt}}=\frac{6at^2}{6at}$	1
		$\therefore \frac{dy}{dx}=t$	1
		---	
	c)	The equation of the tangent at the point $(2, 3)$ on the curve $y=ax^3+b$ is $y=4x-5$. Find the value of 'a' and 'b'.	**04**
	Ans	$y=ax^3+b$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	c)	$\therefore \frac{dy}{dx} = 3ax^2$	1
		$\therefore$ slope $m = \frac{dy}{dx} = 3a(2)^2 = 12a$	½
		Q the equation of tangent is $y = 4x - 5$	
		$\therefore$ slope $m = 4$	½
		$\therefore 12a = 4 \quad \therefore a = \frac{4}{12} = \frac{1}{3}$	1
		Q the point (2, 3) is on the curve $y = ax^3 + b$	
		$\therefore 3 = a(2)^3 + b$	
		$\therefore b = 3 - 8a = 3 - 8\left(\frac{1}{3}\right) = \frac{1}{3}$	1
		---	
	d)	Find radius of curvature of the curve $y^2 = 4ax$ at $(a, 2a)$	**04**
	Ans	$y^2 = 4ax$	
		$\therefore 2y\frac{dy}{dx} = 4a$	1
		$\therefore \frac{dy}{dx} = \frac{2a}{y}$	
		$\therefore \frac{d^2y}{dx^2} = -\frac{2a}{y^2}\frac{dy}{dx}$	1
		$\therefore \frac{d^2y}{dx^2} = -\frac{2a}{y^2}\left(\frac{2a}{y}\right) = -\frac{4a^2}{y^3}$	
		at $(a, 2a)$	
		$\therefore \frac{dy}{dx} = \frac{2a}{2a} = 1$	½
		$\therefore \frac{d^2y}{dx^2} = -\frac{4a^2}{(2a)^3} = -\frac{1}{2a}$	½
		$\therefore$ Radius of curvature is $\rho = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}{\frac{d^2y}{dx^2}}$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.		$\therefore$ Radius of curvature is $\rho = \dfrac{\left[1+(1)^2\right]^{\frac{3}{2}}}{-\dfrac{1}{2a}}$ $\therefore \rho = -2a\left[1+(1)^2\right]^{\frac{3}{2}}$ $\therefore \rho = -(5.656)a$ $\therefore \rho = (5.656)a$	1
3.		**Solve any THREE of the following**	**12**
	a)	A manufacture can sell x $(x \geq 0)$ items at price is of Rs.$(330-x)$ each. The cost of producing x items in Rs. $x^2+10x+12$. How many items must be sold so that his profit is maximum.	**04**
	Ans	Let number of item be x Selling price $= (330-x)x = 330x - x^2$ Cost price $= x^2+10x+12$ profit = selling price – cost price $\therefore p = 330x - x^2 - (x^2+10x+12)$ $p = 320x - 2x^2 - 12$ $\therefore \dfrac{dp}{dx} = 320 - 4x$ $\dfrac{d^2p}{dx^2} = -4$ $\therefore$ profit is maximum Let $320 - 4x = 0$ $x = 80$ $\therefore 80$ items must be sold so that his profit is maximum.	½ ½ 1 1 1

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.	b)	If $y=\tan^{-1}\left(\frac{2x}{1+15x^2}\right)$ find $\frac{dy}{dx}$	**04**
	Ans	$y=\tan^{-1}\left(\frac{5x-3x}{1+(5x)(3x)}\right)$	1
		$\therefore y=\tan^{-1}(5x)-\tan^{-1}(3x)$	1
		$\therefore \frac{dy}{dx}=\frac{1}{1+(5x)^2}(5)-\frac{1}{1+(3x)^2}(3)$	1
		$\therefore \frac{dy}{dx}=\frac{5}{1+25x^2}-\frac{3}{1+9x^2}$	1
		---	
	c)	Evaluate $\int\frac{\sin\left(\sqrt{x}\right)}{\sqrt{x}}dx$	**04**
	Ans	$\int\frac{\sin\left(\sqrt{x}\right)}{\sqrt{x}}dx$	
		Put $\sqrt{x}=t$	
		$\therefore \frac{1}{2\sqrt{x}}dx=dt$	1
		$\therefore \frac{1}{\sqrt{x}}dx=2dt$	
		$\therefore \int\sin t.2dt$	1
		$=2\int\sin t dt$	1
		$=2(-\cos t)+c$	1
		$=-2\cos\left(\sqrt{x}\right)+c$	
		---	
	d)	Find $\frac{dy}{dx}$ if $y=(\sin x)^{\tan x}$	**04**
	Ans	$y=(\sin x)^{\tan x}$	
		$\therefore \log y=\log(\sin x)^{\tan x}$	
		$\log y=\tan x\log(\sin x)$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.	d)	$\frac{1}{y}\frac{dy}{dx} = \tan x \frac{1}{\sin x}\cos x + \log(\sin x)\sec^2 x$	2
		$\frac{1}{y}\frac{dy}{dx} = \tan x \cot x + \sec^2 x \log(\sin x)$	1
		$\frac{dy}{dx} = y\left(1+\sec^2 x \log(\sin x)\right)$	
		$\frac{dy}{dx} = (\sin x)^{\tan x}\left(1+\sec^2 x \log(\sin x)\right)$	½

4.		**Solve any THREE of the following:**	**12**
	a)	Evaluate: $\int \frac{1}{\sqrt{13-6x-x^2}}\,dx$	
	Ans	$\int \frac{1}{\sqrt{13-6x-x^2}}\,dx$	
		Third term $= \frac{(-6)^2}{4} = 9$	1
		$\therefore \int \frac{1}{\sqrt{13+9-9-6x-x^2}}\,dx$	1
		$= \int \frac{1}{\sqrt{22-(9+6x+x^2)}}\,dx$	
		$= \int \frac{1}{\sqrt{(\sqrt{22})^2-(x+3)^2}}\,dx$	1
		$= \sin^{-1}\left(\frac{x+3}{\sqrt{22}}\right)+c$	1
		---	
	b)	Evaluate : $\int \frac{1}{3+2\sin x}\,dx$	**04**
	Ans	$\int \frac{1}{3+2\sin x}\,dx$	
		Put $\tan\frac{x}{2} = t$, $\sin x = \frac{2t}{1+t^2}$, $dx = \frac{2dt}{1+t^2}$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.		$\therefore \int \frac{1}{3+2\sin x}\,dx$	
		$= \int \frac{1}{3+2\left(\frac{2t}{1+t^2}\right)} \cdot \frac{2dt}{1+t^2}$	½
		$= 2\int \frac{1}{3t^2+4t+3}\,dt$	½
		$= \frac{2}{3}\int \frac{1}{t^2+\frac{4}{3}t+1}\,dt$	
		Third term $= \frac{\left(\frac{4}{3}\right)^2}{4} = \frac{4}{9}$	½
		$= \frac{2}{3}\int \frac{1}{t^2+\frac{4}{3}t+\frac{4}{9}-\frac{4}{9}+1}\,dt$	½
		$= \frac{2}{3}\int \frac{1}{\left(t+\frac{2}{3}\right)^2+\left(\frac{\sqrt{5}}{3}\right)^2}\,dt$	½
		$= \frac{2}{3}\frac{1}{\left(\frac{\sqrt{5}}{3}\right)}\tan^{-1}\left(\frac{t+\frac{2}{3}}{\frac{\sqrt{5}}{3}}\right)+c$	1
		$= \frac{2}{\sqrt{5}}\tan^{-1}\left(\frac{3t+2}{\sqrt{5}}\right)+c$	
		$= \frac{2}{\sqrt{5}}\tan^{-1}\left(\frac{3\tan\left(\frac{x}{2}\right)+2}{\sqrt{5}}\right)+c$	½
		---	
	c)	Evalute: $\int e^x.\sin 4x dx$	**04**
	Ans	Let $\int e^x.\sin 4x dx$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.	c)	$= \sin 4x\int e^x dx - \int\left(\int e^x dx \frac{d}{dx}\sin 4x\right).dx$	½
		$= \sin 4x.e^x - \int \cos 4x \cdot 4 \cdot e^x dx$	½
		$= e^x \sin 4x - 4\left[\cos 4x\int e^x dx - \int\left(\int e^x dx \cdot \frac{d}{dx}\cos 4x\right)dx\right]$	½
		$= e^x \sin 4x - 4\left[\cos 4x\left(e^x\right) - \int\left(-\sin 4x \cdot 4 \cdot e^x\right)dx\right]$	½
		$= e^x \sin 4x - 4\left[e^x \cos 4x + 4\int e^x \sin 4x dx\right]$	½
		$= e^x \sin 4x - 4e^x \cos 4x - 16I$	½
		$I + 16I = e^x \sin 4x - 4e^x \cos 4x$	
		$17I = e^x \sin 4xe^x - 4e^x \cos 4x$	½
		$I = \frac{e^x}{17}\left(\sin 4x - 4\cos 4x\right) + c$	½
		---	
	d)	Evaluate : $\int \frac{\log x}{x\left(2+\log\right)\left(3+\log x\right)}\,dx$	**04**
	Ans	$\int \frac{\log x}{x\left(2+\log\right)\left(3+\log x\right)}\,dx$ $\quad \begin{vmatrix} Put\ \log x = t \\ \therefore \frac{1}{x}dx = dt \end{vmatrix}$	½
		$\int \frac{t}{\left(2+t\right)\left(3+t\right)}\,dt$	
		consider $\frac{t}{\left(2+t\right)\left(3+t\right)} = \frac{A}{2+t} + \frac{B}{3+t}$	½
		$\therefore t = A\left(3+t\right) + B\left(2+t\right)$	
		Put $t = -2$	
		$A = -2$	½
		Put $t = -3$	
		$B = 3$	½
		$\therefore \frac{t}{\left(2+t\right)\left(3+t\right)} = \frac{-2}{2+t} + \frac{3}{3+t}$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.	d)	$\therefore \int \frac{t}{(2+t)(3+t)}\,dt = \int\left(\frac{-2}{2+t}+\frac{3}{3+t}\right)dt$	½
		$= -2\log(2+t)+3\log(3+t)+c$	1
		$= -2\log(2+\log x)+3\log(3+\log x)+c$	½
		---	
	e)	Evaluate: $\int_0^5 \frac{\sqrt{9-x}}{\sqrt{9-x}+\sqrt{x+4}}\,dx$	**04**
	Ans	$I = \int_0^5 \frac{\sqrt{9-x}}{\sqrt{9-x}+\sqrt{x+4}}\,dx \quad -------(1)$	
		$I = \int_0^5 \frac{\sqrt{9-(5-x)}}{\sqrt{9-(5-x)}+\sqrt{(5-x)+4}}\,dx$	1
		$\therefore I = \int_0^5 \frac{\sqrt{x+4}}{\sqrt{x+4}+\sqrt{9-x}}\,dx \quad -------(2)$	1
		add (1) and (2)	
		$I+I = \int_0^5 \frac{\sqrt{9-x}}{\sqrt{9-x}+\sqrt{x+4}}\,dx + \int_0^5 \frac{\sqrt{x+4}}{\sqrt{x+4}+\sqrt{9-x}}\,dx$	
		$\therefore 2I = \int_0^5 \frac{\sqrt{9-x}+\sqrt{x+4}}{\sqrt{9-x}+\sqrt{x+4}}\,dx$	½
		$\therefore 2I = \int_0^5 1\,dx$	
		$\therefore 2I = [x]_0^5$	1
		$\therefore 2I = 5-0$	
		$\therefore 2I = 5$	
		$I = \frac{5}{2}$	½

5.		**Solve any <u>TWO</u> of the following:**	**12**
	a)	Find the area bounded by the parabola $y^2 = 4x$ and $x^2 = 4y$.	**06**
	Ans	$y^2 = 4x \quad ---------(1)$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.	a)	$x^2 = 4y \therefore y = \frac{x^2}{4}$	
		$\therefore \text{eq}^{\text{n}}.(1) \Rightarrow \left(\frac{x^2}{4}\right)^2 = 4x$	
		$\frac{x^4}{16} = 4x$	1
		$\therefore x^4 = 64x$	
		$\therefore x^4 - 64x = 0$	
		$\therefore x\left(x^3 - 64\right) = 0$	
		$\therefore x = 0, 4$	1
		$\text{Area } A = \int_a^b (y_1 - y_2)\, dx$	
		$\therefore A = \int_0^4 \left(2\sqrt{x} - \frac{x^2}{4}\right) dx$	
		$\therefore A = \int_0^4 \left(2x^{\frac{1}{2}} - \frac{x^2}{4}\right) dx$	1
		$\therefore A = \left(\frac{2x^{\frac{3}{2}}}{\frac{3}{2}} - \frac{x^3}{12}\right)_0^4$	1
		$\therefore A = \left(\frac{2(4)^{\frac{3}{2}}}{\frac{3}{2}} - \frac{(4)^3}{12}\right) - 0$	1
		$\therefore A = \frac{16}{3}$ or 5.333	1
		---	
	b) i) Ans	Solve : $x^2 y\, dx - \left(x^3 + y^3\right) dy = 0$ (Example is of homogeneous D.E which is out of syllabus if student attempted to solve give appropriate marks)	**03**
		$x^2 y\, dx - \left(x^3 + y^3\right) dy = 0$	
		$\frac{dy}{dx} = \frac{x^2 y}{x^3 + y^3}$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.		$y = vx$	
		$\frac{dy}{dx} = v + x\frac{dv}{dx}$	½
		$v + x\frac{dv}{dx} = \frac{x^2(vx)}{x^3 + (vx)^3}$	
		$v + x\frac{dv}{dx} = \frac{vx^3}{x^3 + v^3x^3}$	½
		$v + x\frac{dv}{dx} = \frac{v}{1+v^3}$	
		$x\frac{dv}{dx} = \frac{v}{1+v^3} - v$	
		$x\frac{dv}{dx} = \frac{v - v - v^4}{1+v^3}$	
		$x\frac{dv}{dx} = \frac{-v^4}{1+v^3}$	
		$\frac{1+v^3}{v^4}dv = -\frac{dx}{x}$	½
		solution is	
		$\int \frac{1+v^3}{v^4}dv = -\int \frac{dx}{x}$	
		$\int \left(v^{-4} + \frac{1}{v}\right)dv = -\int \frac{dx}{x}$	
		$\frac{v^{-3}}{-3} + \log v = -\log x + c$	1
		$\frac{\left(\frac{y}{x}\right)^{-3}}{-3} + \log\frac{y}{x} = -\log x + c$	½
		---	
	ii)	Form the differential equation of $y = a\cos 4x + b\sin 4x$	**03**
	Ans	$y = a\cos 4x + b\sin 4x$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.		$\therefore \frac{dy}{dx} = -4a\sin 4x + 4b\cos 4x$	1
		$\therefore \frac{d^2y}{dx^2} = -16a\cos 4x - 16b\sin 4x$	1
		$\therefore \frac{d^2y}{dx^2} = -16\left(a\cos 4x + b\sin 4x\right)$	
		$\frac{d^2y}{dx^2} = -16y$	
		$\frac{d^2y}{dx^2} + 16y = 0$	1
		---	
	c)	Acceleration of moving particle at the end of $'t'$ second. From the start of it's motion is $\left(5-2t\right) m/s^2$.Find it's velocity at the end of 3 seconds and distance travelled by it during the period. If it's initial velocity is $4\ m/s$.	**06**
	Ans	Acceleration = $\frac{dv}{dt} = 5-2t$	
		$\therefore dv = \left(5-2t\right)dt$	
		$\therefore \int dv = \int \left(5-2t\right)dt$	
		$\therefore v = 5t - t^2 + c$	1
		given $v = 4$ and $t = 0$	
		$\therefore c = 4$	1
		$\therefore v = 5t - t^2 + 4$	
		$\therefore \frac{dx}{dt} = 5t - t^2 + 4$	½
		$\therefore \int dx = \int \left(5t - t^2 + 4\right)dt$	½
		$\therefore x = \frac{5t^2}{2} - \frac{t^3}{3} + 4t + c$	1
		initially $x = 0$ and $t = 0$	
		$\therefore c = 0$	1

Q. No.	Sub Q. N.	Answer	Marking Scheme
	c)	$\therefore x = \frac{5t^2}{2} - \frac{t^3}{3} + 4t$ at $t = 3$ $\therefore x = \frac{5(3)^2}{2} - \frac{(3)^3}{3} + 4(3)$ $\therefore x = \frac{51}{2}\ m$ or $25.5\ m$	1
6.		**Solve any TWO of the following:**	**12**
	a)	If 20% of the bolt produce by a machine are defective .Find the Probability that out of 4 bolts drawn. i) one is defective ii) at the most two are defective.	**06**
	Ans	Given $p = 20\% = \frac{20}{100} = 0.2, n = 4$ and $q = 1 - p = 0.8$	1
		$p(r) = {}^nC_r\, p^r q^{n-r}$	
		i) $p(\text{one is defective})$	
		$= p(1) = 4C_1 (0.2)^1 (0.8)^{4-1}$	1
		$= 0.4096$	1
		ii) $p(\text{at the most two are defective.})$	
		$= p(0) + p(1) + p(2)$	1
		$= 4C_0 (0.2)^0 (0.8)^{4-0} + 4C_1 (0.2)^1 (0.8)^{4-1} + 4C_2 (0.2)^2 (0.8)^{4-2}$	1
		$= 0.9728$	1
	b)	If the probability of a bad reaction from the certain injection is 0.001, determine the chance that out of 2000 individuals more than two will get a bad reaction. $(\text{Given } e^2 = 7.4)$	**06**
	Ans	$p = 0.001,\ n = 2000$ $\therefore m = np = 0.001 \times 2000 = 2$	2

Q. N.	Sub Q. N.	Answer	Marking Scheme
	Ans	$p(r)=\frac{e^{-m}\cdot(m)^r}{r!}$ more than two will get a bad reaction $=1-\left(p(0)+p(1)+p(2)\right)$ $=1-\left(\frac{e^{-2}\cdot(2)^0}{0!}+\frac{e^{-2}\cdot(2)^1}{1!}+\frac{e^{-2}\cdot(2)^2}{2!}\right)$	2
		$=0.3243$	2
	c)	In a sample of 1000 cases the mean of certain test is 14 and S. D. is 2.5. Assuming the distribution to be normal,find i) How many students score between 12 and 15? ii) How many students score above 18? $\left[\text{Given: } A(0.8)=0.2881,\ A(0.4)=0.1554,\ A(1.6)=0.4452\right]$	**06**
	Ans	Given $\bar{x}=14 \quad \sigma=2.5 \quad N=1000$	
		i) $z=\frac{x-\bar{x}}{\sigma}=\frac{18-14}{2.5}=1.6$	1
		$\therefore p(\text{ score above } 18)=A(\text{greater than } 1.6)$	
		$=0.5-A(1.6)$	
		$=0.5-0.4452=0.0548$	1
		$\therefore$ No. of students $=N\cdot p$	1
		$=1000\times 0.0548=54.8$ *i.e.*, 55	
		ii) $z=\frac{x-\bar{x}}{\sigma}=\frac{12-14}{2.5}=-0.8$	½
		$z=\frac{x-\bar{x}}{\sigma}=\frac{15-14}{2.5}=0.4$	½
		$\therefore p(\text{score between 12 and 15})=A(-0.8)+A(0.4)$	
		$=0.2881+0.1554$	1
		$=0.4435$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
		$\therefore$ No. of students $= N \cdot p = 1000 \times 0.4435$ $= 443.5$ *i.e.*, 444 --- ***Important Note*** *In the solution of the question paper, wherever possible all the possible alternative methods of solution are given for the sake of convenience. Still student may follow a method other than the given herein. In such case, first see whether the method falls within the scope of the curriculum, and then only give appropriate marks in accordance with the scheme of marking.* ---	1

22207

21222

4 Hours / 70 Marks

Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Retain all construction lines.

Marks

1. Solve any FIVE : **10**

(a) Draw a proportionate free hand sketch of Muff Coupling.

(b) Sketch two views of single rivetted lap joint.

(c) Draw a proportionate free hand sketch of cup head rivet.

(d) Draw free hand sketch of cone pully drive.

(e) Draw neat, proportionate free hand sketch of eye foundation bolt.

(f) Draw conventional presentation of following material :

(i) Bronze

(ii) Concrete

(g) Draw the conventional presentation of following welded joint :

(i) Double bevel butt joint

(ii) Spot joint

2. Solve any THREE : **12**

(a) A line AB, 65 mm long is inclined to HP at an angle of 45º. Its end A is 15 mm above HP and 25 mm infront of VP. Line AB is contained by a vertical plane making an angle of 45º to VP. Draw the projections of line and find inclinations of the line with VP.

(b) An ellipse of major axis 70 mm is seen as a circle of 50 mm diameter in the top view. Find out its inclination with HP and also draw its side view.

(c) A pentagonal plate 40 mm side has its corner on the VP. The plate is inclined to VP in such a way that the elevation length of two sides is each 35 mm. One side is perpendicular to HP. Draw three views of the plate and find its inclination with VP.

(d) A square pyramid of 40 mm side of base and axis length 60 mm is kept on HP on a corner of its base such that its axis makes an angle of 30º to HP and parallel to VP. Draw the projections.

(e) A tetrahedron of 60 mm length of edge is kept on HP on one of its edges in such a way that its axis makes an angle of 45º with HP and parallel to VP. Draw its projection.

3. Solve any TWO : **16**

(a) A cone diameter of base 60 mm and height 70 mm is suspended by a string attached to the mid point of any one of its generators. Draw the projections of the solid and find the inclination of the axis with HP. Consider axis parallel to VP.

(b) A hexagonal pyramid, base 25 mm and axis 65 mm long is resting on its base on HP with two sides of base parallel to VP. It is cut by a section plane, perpendicular to VP and inclined at 45º to HP and intersecting the axis at a point 22 mm above base.

Draw :

(i) F.V.

(ii) Sectional T.V. and

(iii) True shape of section

(c) A cone base 50 mm diameter, axis 60 mm long and resting on its base on HP. It is cut by vertical section plane parallel to VP and 10 mm away from the top view of the axis. Draw top view and sectional front view.

4. Solve any TWO : **16**

(a) Fig.-1 shows the pictorial view of an object.

Draw :

(i) Sectional front view in the X-direction

(ii) Side view

Use first angle method.

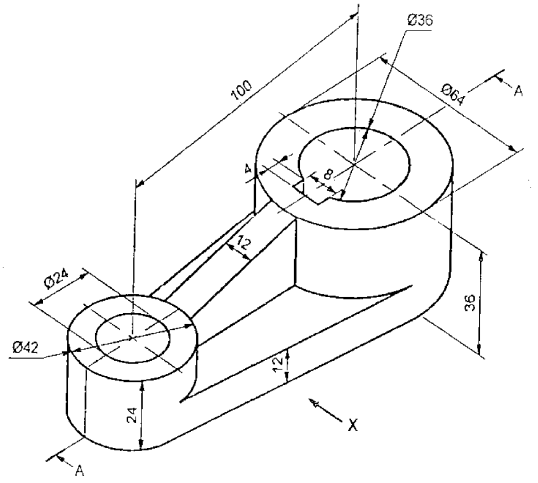


Fig.-1

(b) Fig.-2 shows isometric view of a CI block.

Draw :

(i) Sectional F.V. in the X-direction

(ii) T.V.

(iii) L.H.S.V.

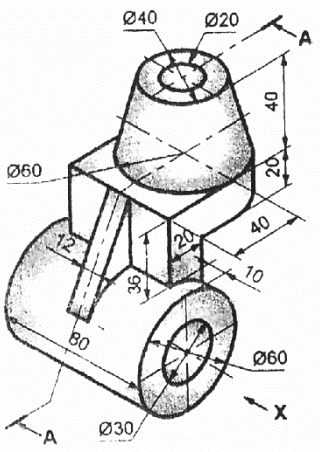


Fig.-2

(c) Fig.-3 shows F.V. and R.H.S.V. of an object. Draw its T.V. and also re-draw the given views.

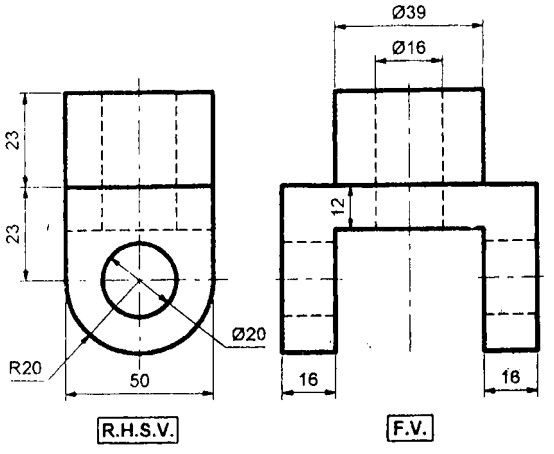


Fig.-3

5. Solve any TWO : **16**

(a) Fig.-4 shows plan and elevation of an object.
Draw :
(i) End view from left
(ii) Sectional elevation
Use first angle method.

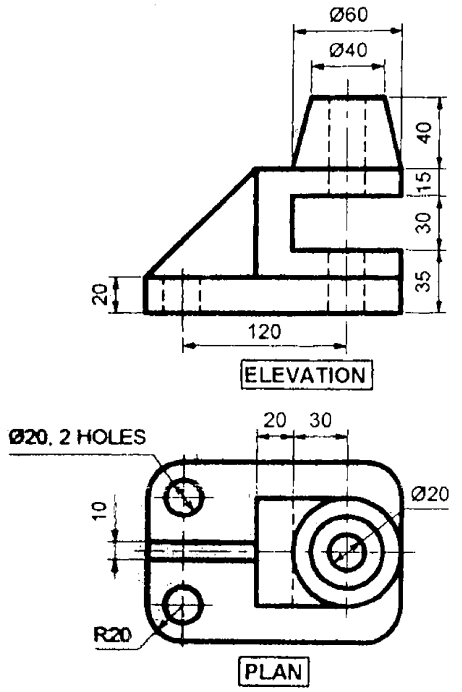


Fig.-4

(b) Fig.-5 shows the incomplete F.V., T.V. and partially auxiliary F.V. Draw the given views and complete the F.V.

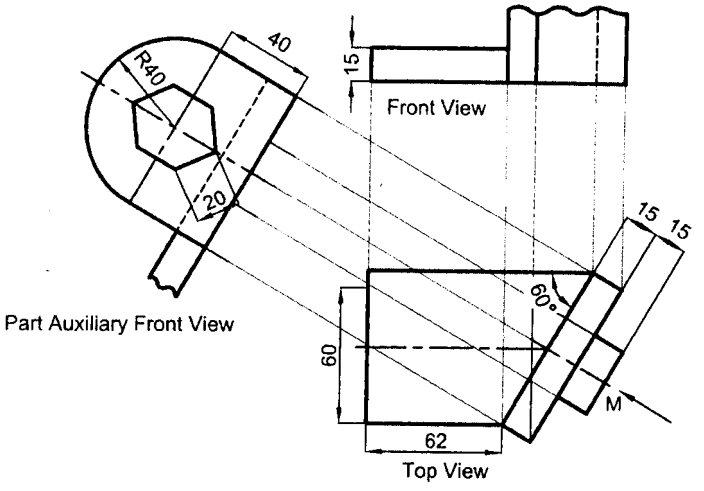


Fig.-5

P.T.O.

(c) Fig.-6 shows the F.V. and S.V. of a block. Draw the given views and project an auxiliary view in the direction of arrow A.

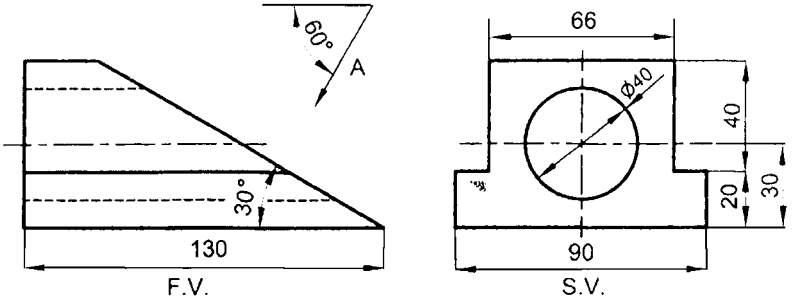


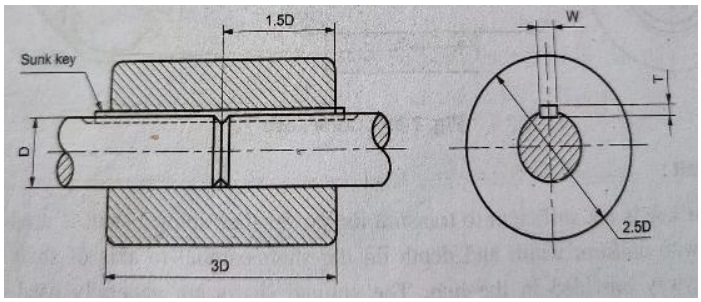
Fig-6

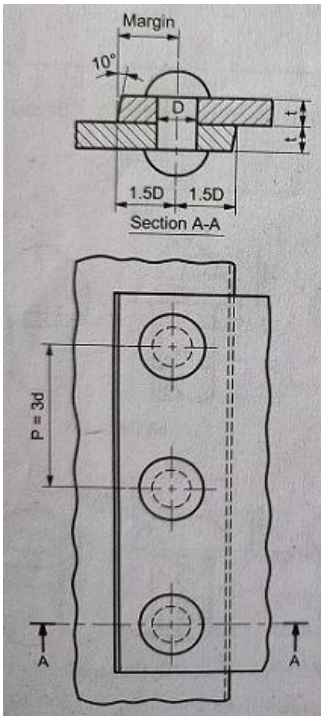
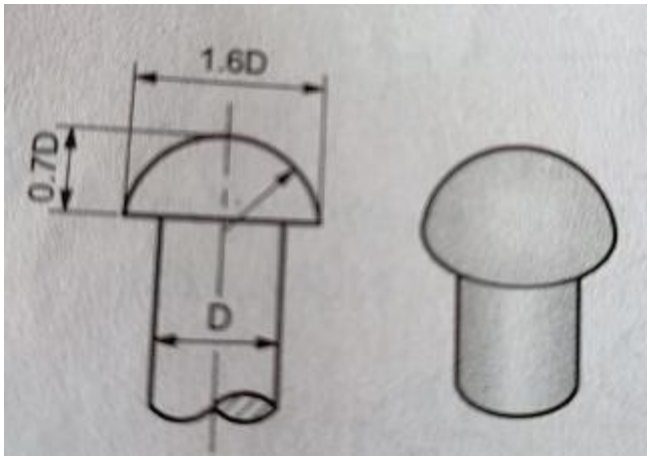
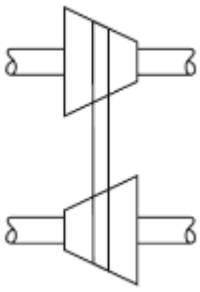
SUMMER – 2022 EXAMINATION

Subject Name: **Model Answer** **Subject Code:** XXXXX

Important Instructions to examiners:

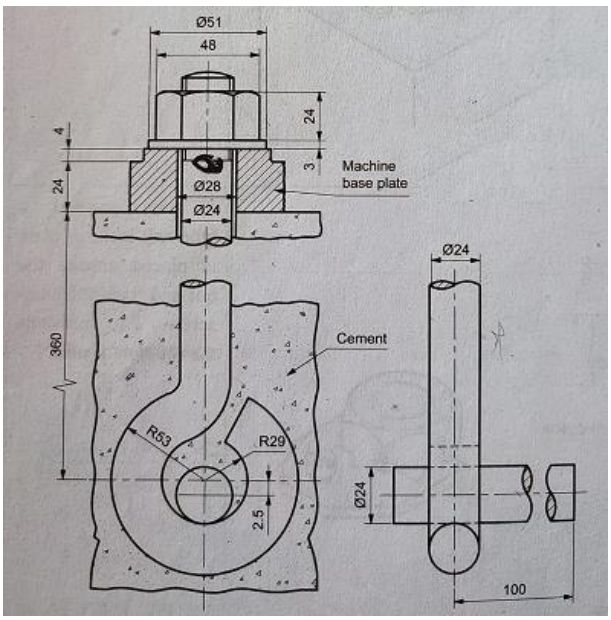
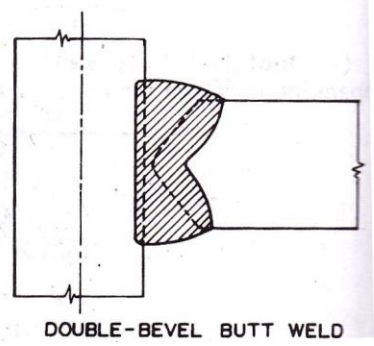
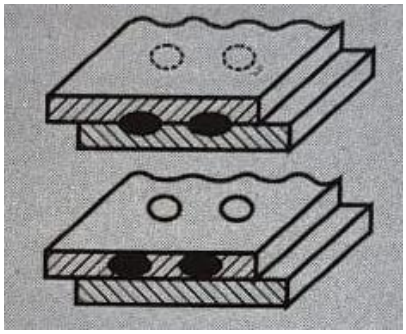
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

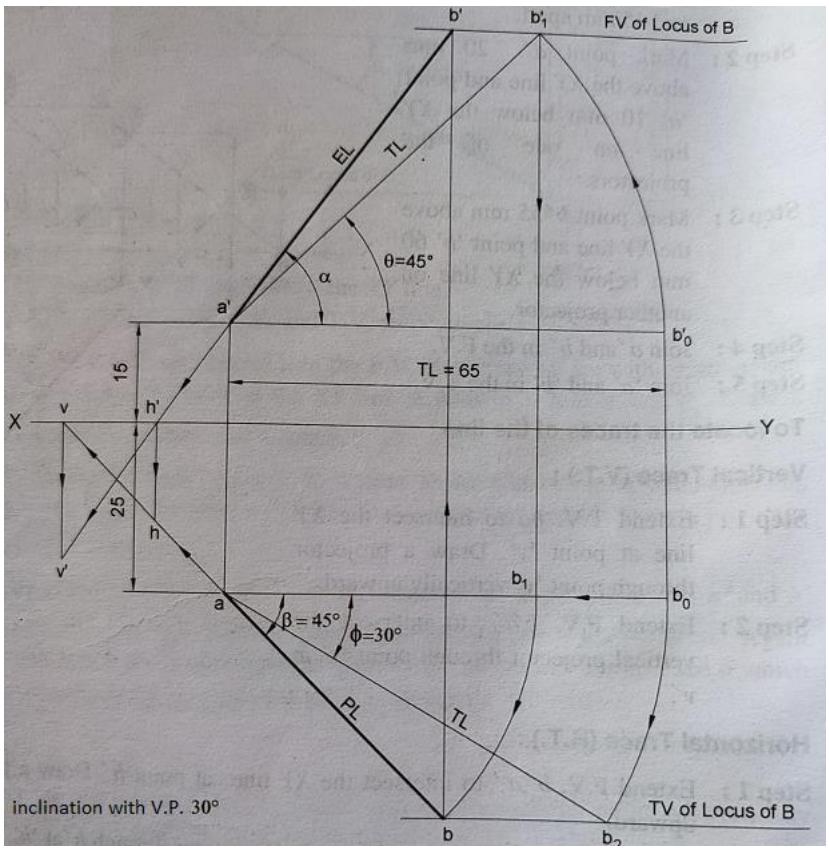
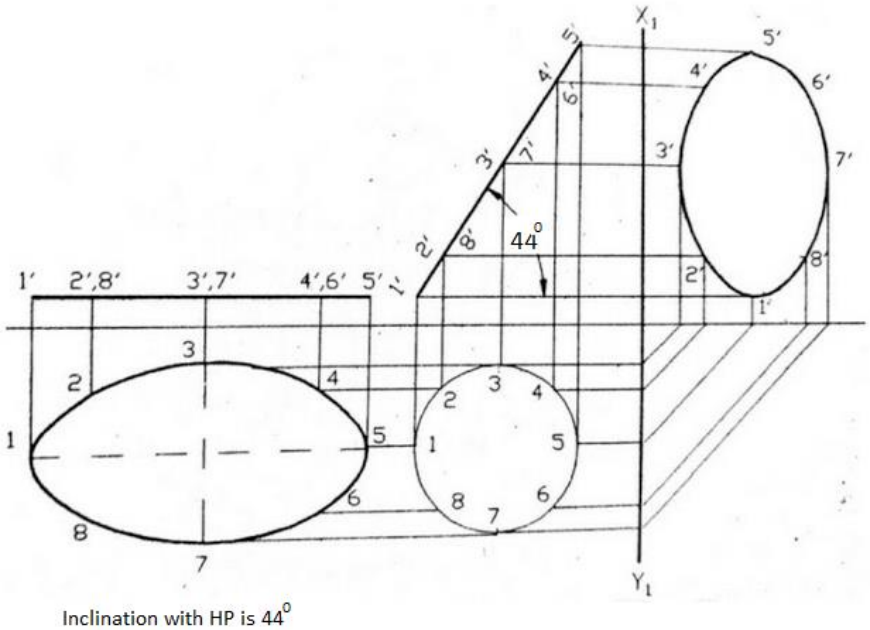
Q. No.	Sub Q. N.	Answer	Marking Scheme
01	a	Solve any five (10 Marks) Muff coupling 	02

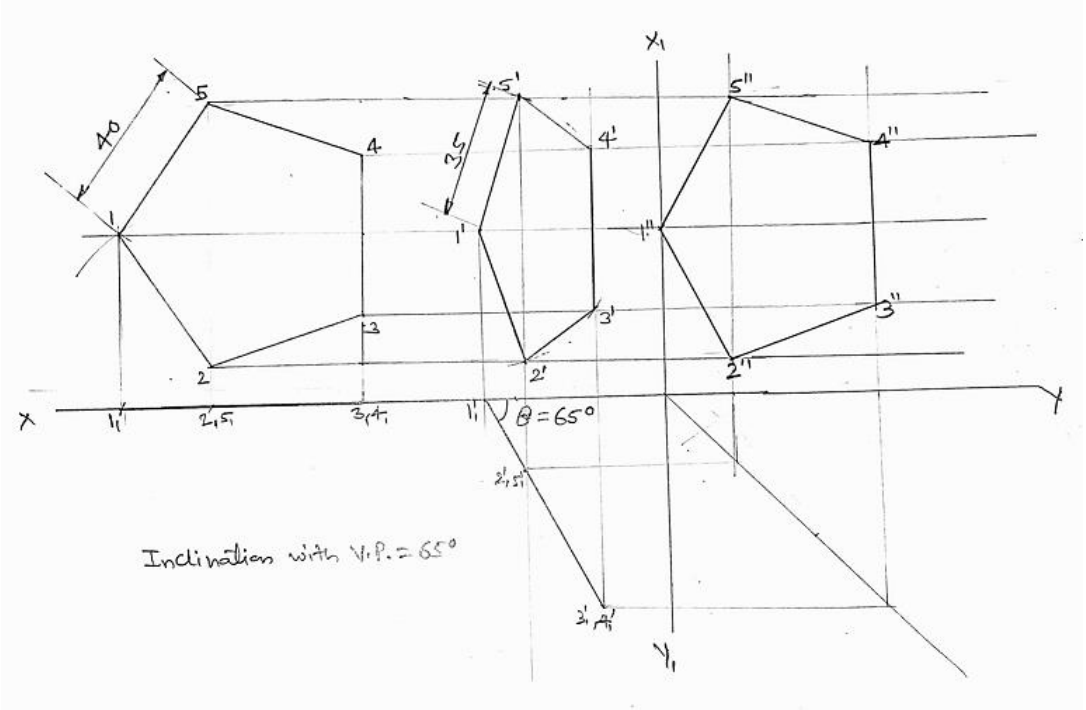
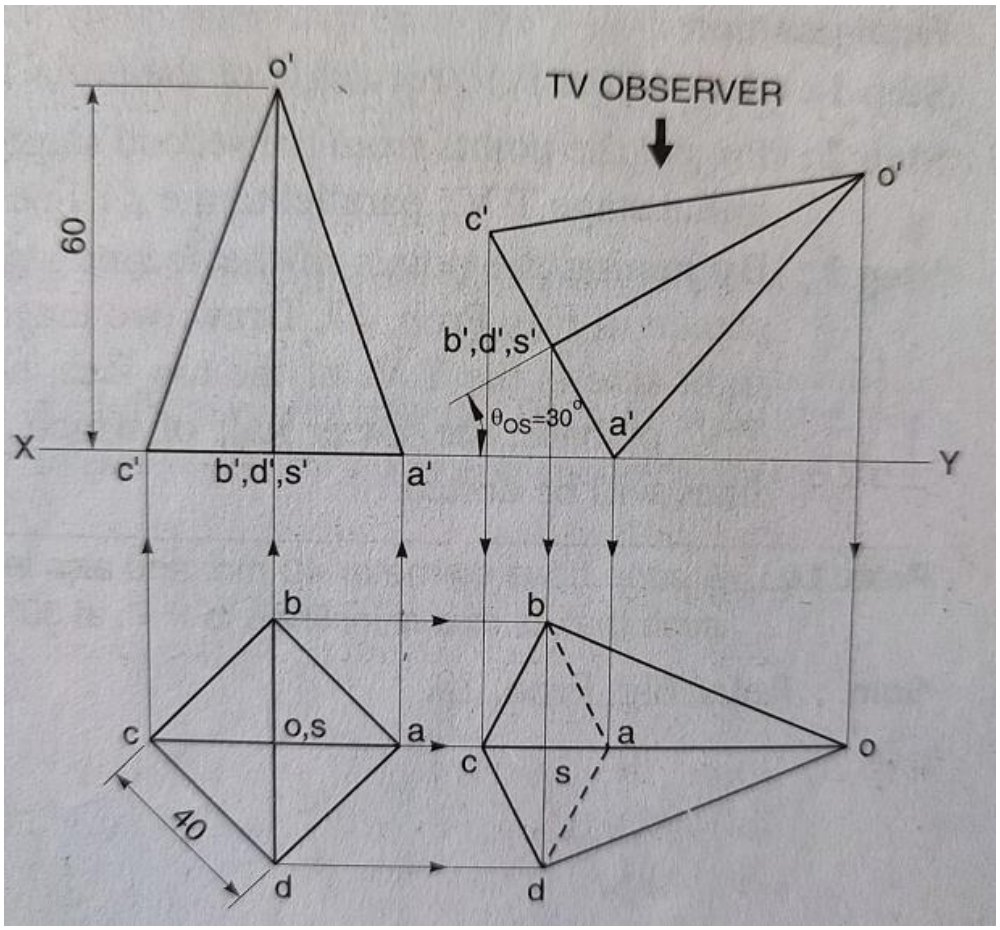
	b	Single Rivetted Lap joint  	02
	c	Cup head rivet  	02
	d	Cone pulley Drive 	02

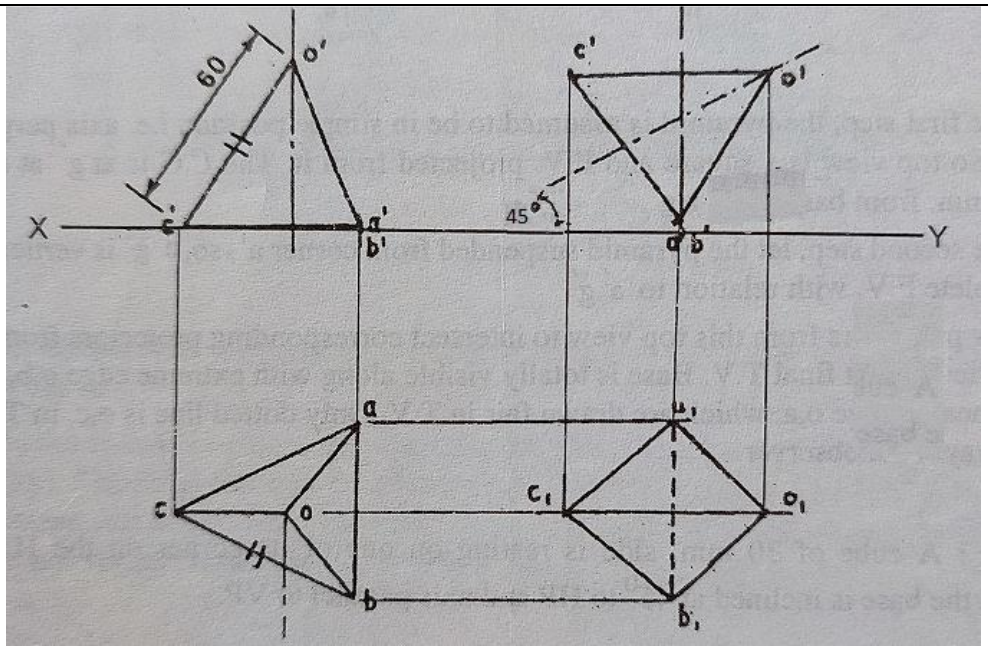
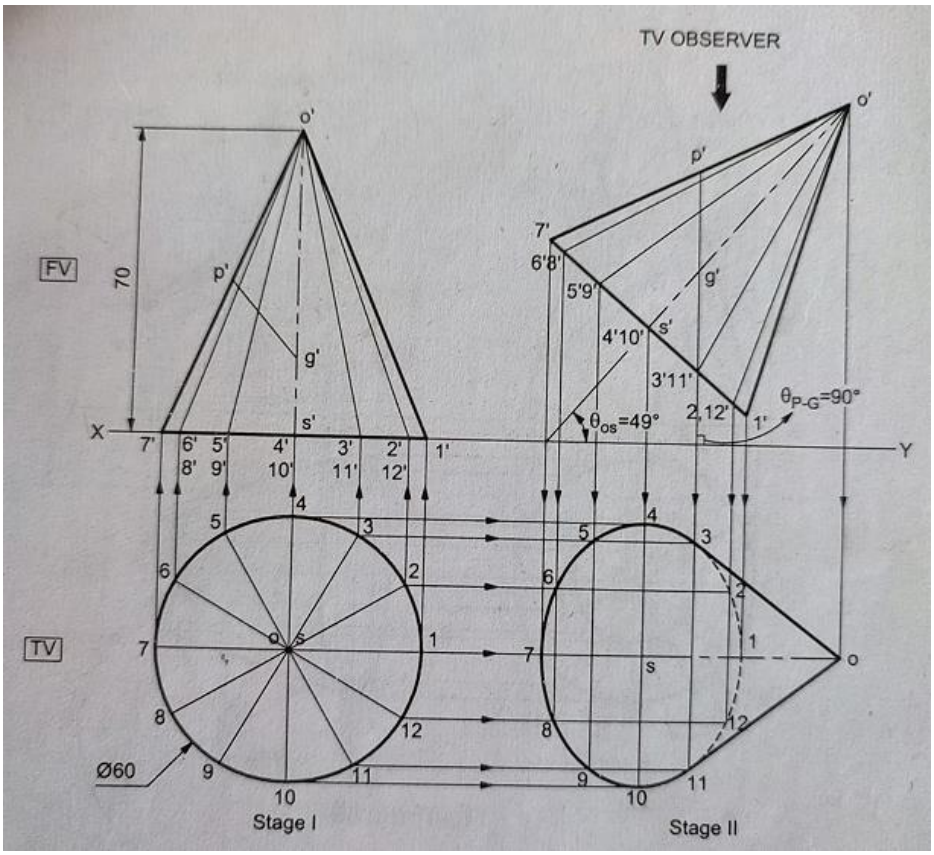
SUMMER – 2022 EXAMINATION

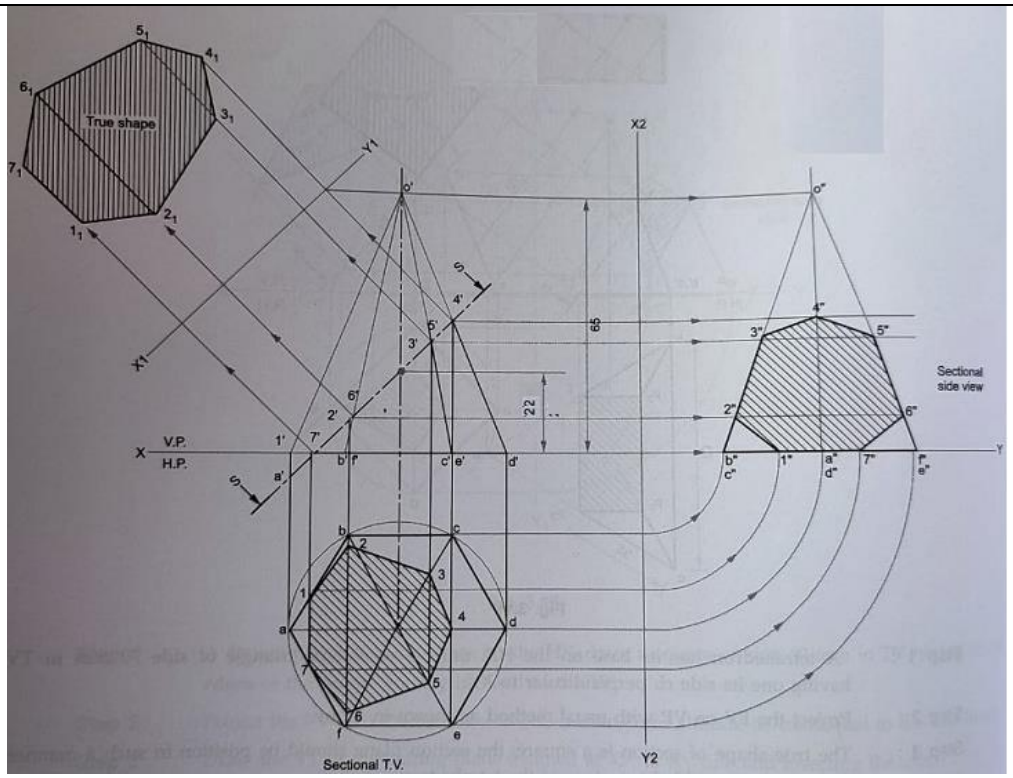
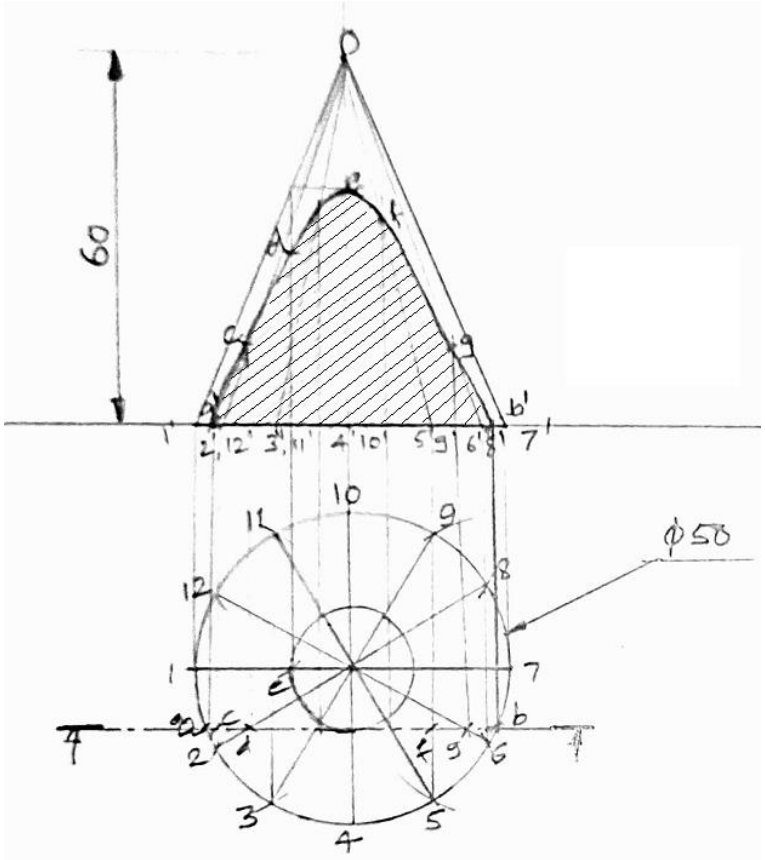
Subject Name: **Model Answer** **Subject Code:** XXXXX

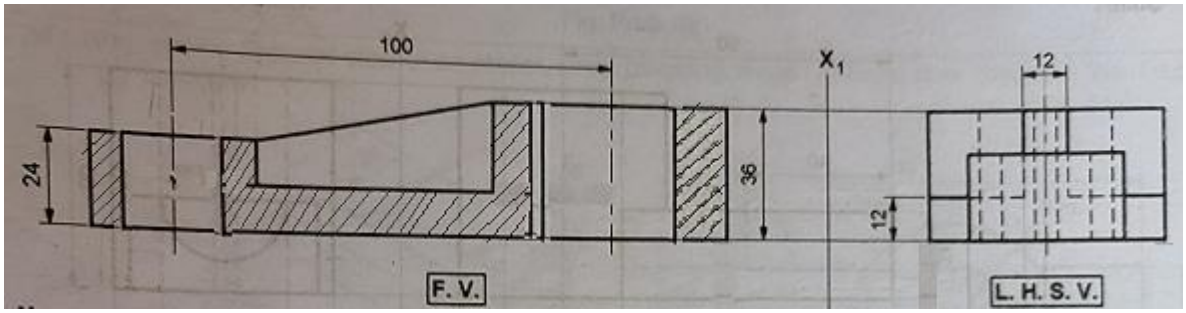
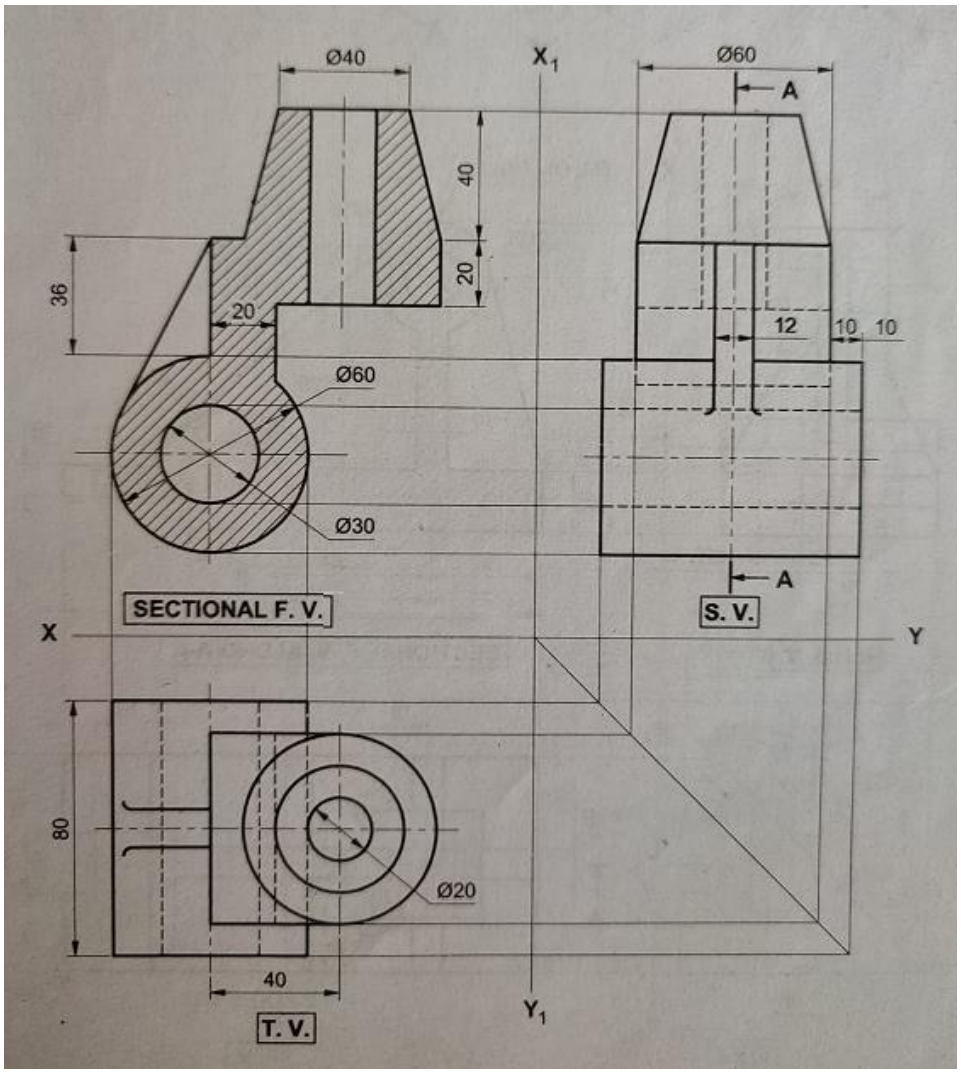
Q. No.	Sub Q. N.	Answer	Marking Scheme
01	e	Eye Foundation bolt 	02
	f	Bronze 01 mark concrete 01 mark 	
	g	Double bevel butt joint 01 mark Spot joint 01 mark  	

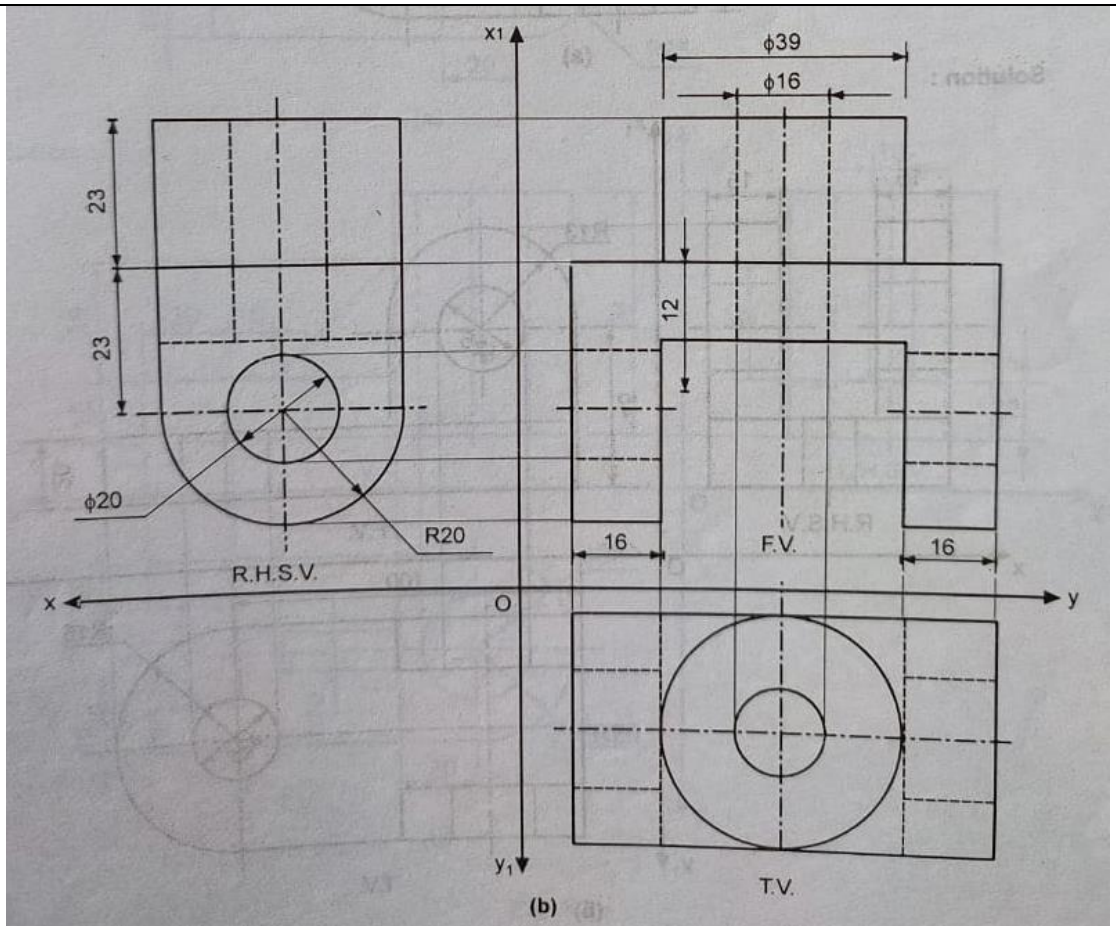
Q. No.	Sub Q. N.	Answer	Marking Scheme
02	a	Solve any three  	04
	b	 	04

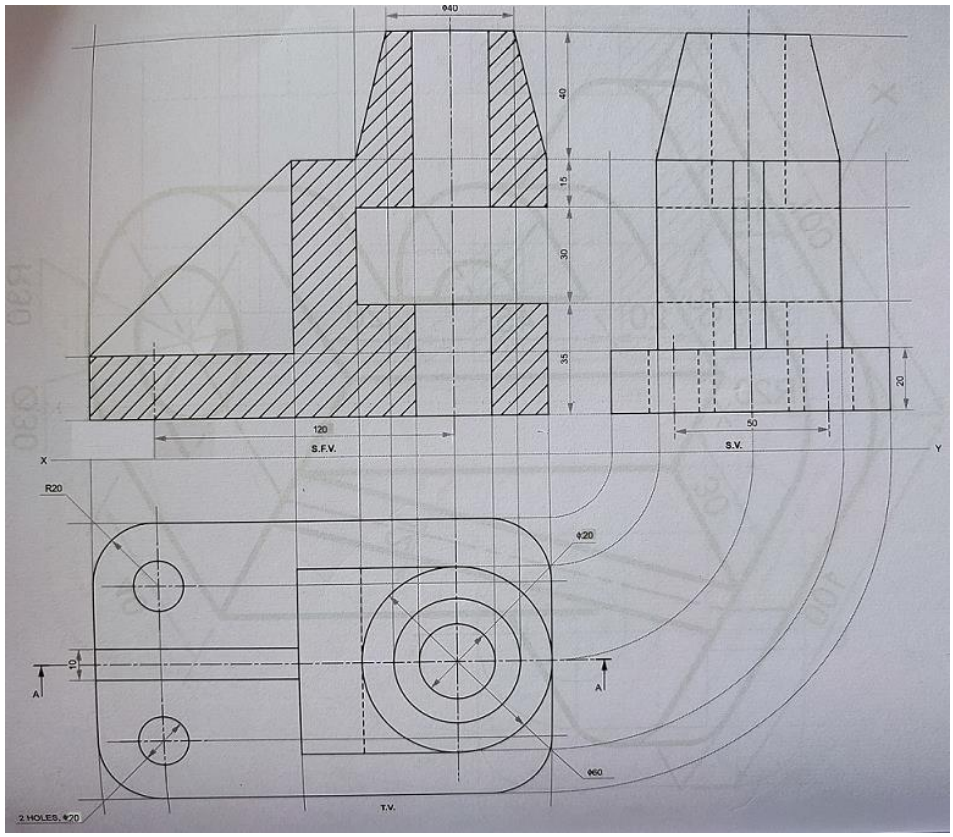
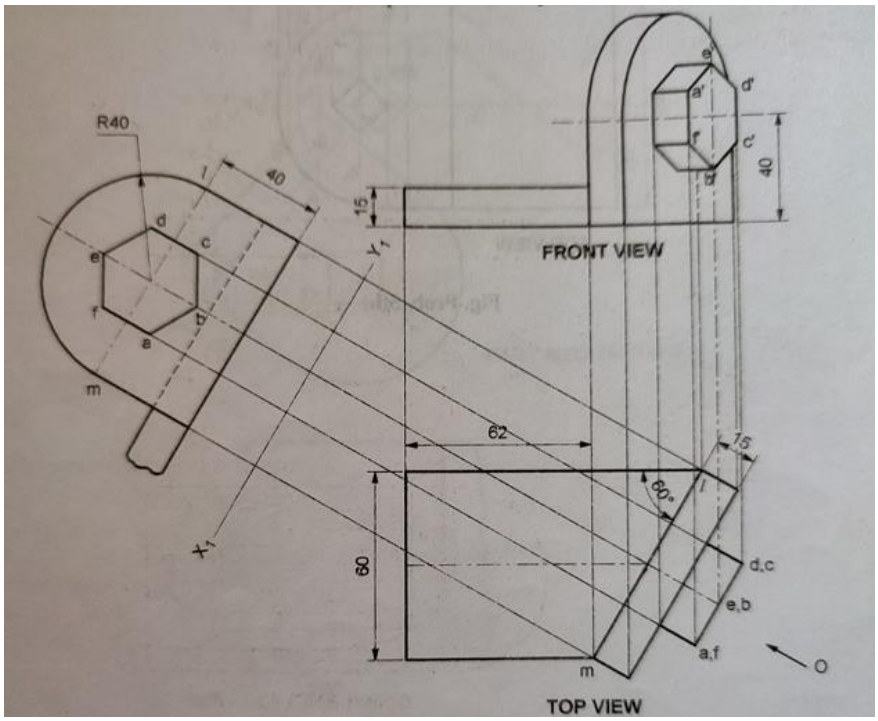
Q. No.	Sub Q. N.	Answer	Marking Scheme
02	C		04
	d		04

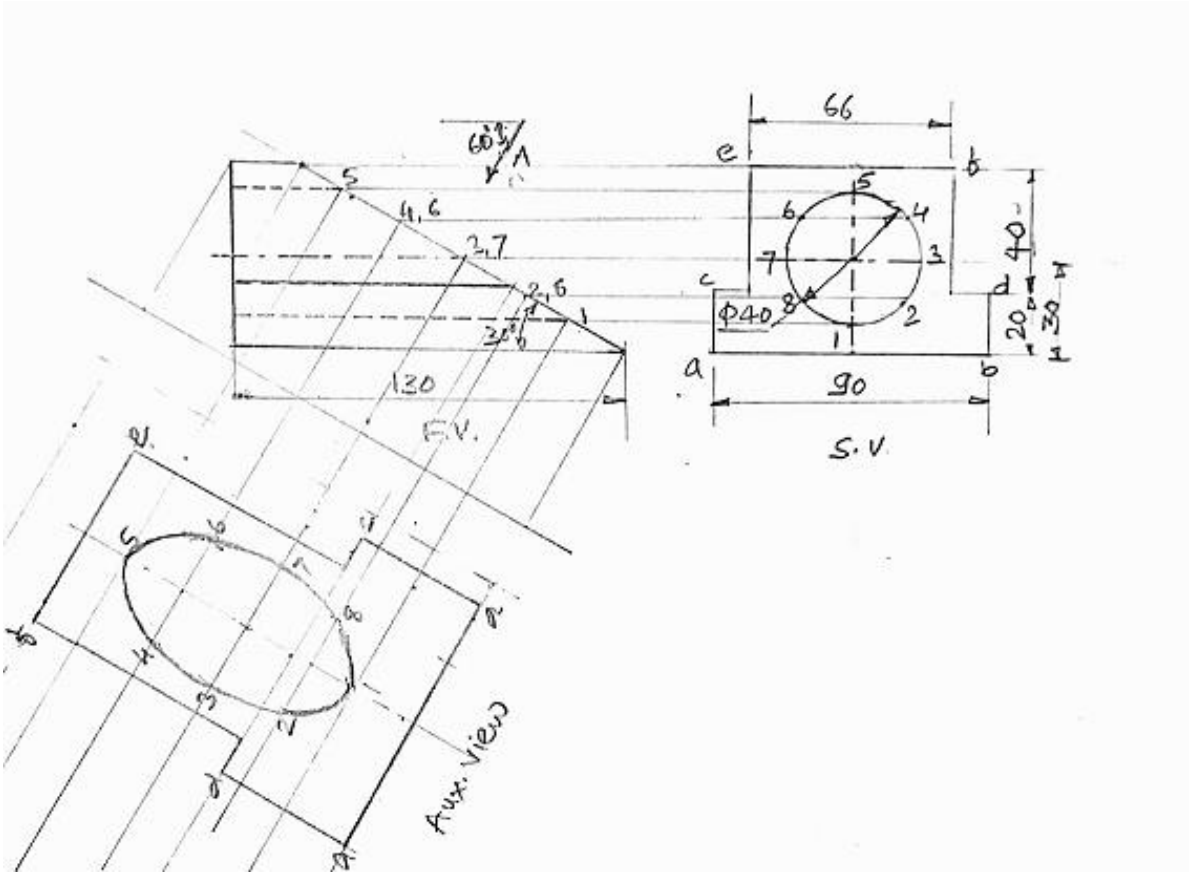
Q. No.	Sub Q. N.	Answer	Marking Scheme
02	e		04
03	a	Solve any two 	stage I - 4 Marks Stage II- 4 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
03	B		F.V.- 2 Marks Sectional T.V.-4 marks True shape - 2 marks
03	c		T.V.- 4 Marks sectional F.V.-4 Marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
04		Solve any two	
	a		sectional F . V. in the X direction - 4 marks side view -4 marks
	b		sectional F,V in the X direction- 4 marks T.V.-2 marks L.H.S.V. - 2 Marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
04	c		Redraw F.V. -2 Marks R H S V. - 2 marks T V - 4 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
5		Solve any two	
	a		End view from left- 4 marks Sectional elevation- 4 marks
05	b		complete F.V.- 4 marks T .V - 2 Marks part auxiliary F.V. - 2 Marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
05	c		F.V.-2 marks S.V. - 2 marks Auxiliary view - 4 Marks

SUMMER – 2022 EXAMINATION

Subject Name: Theory of Machines and Mechanisms **Model Answer** **Subject Code:** **22438**

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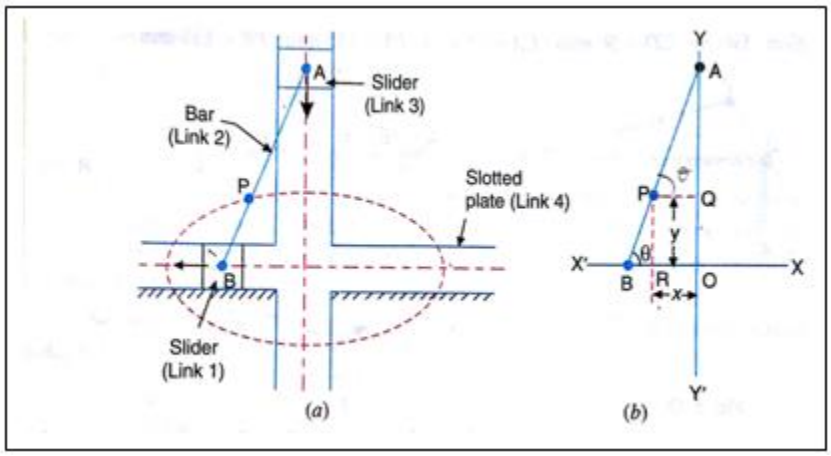
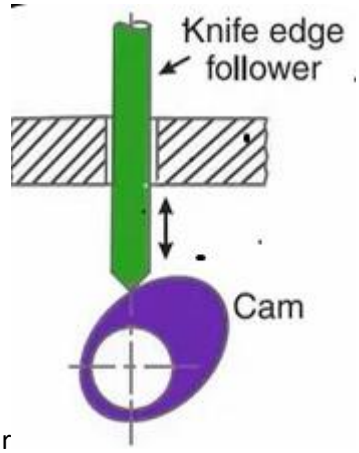
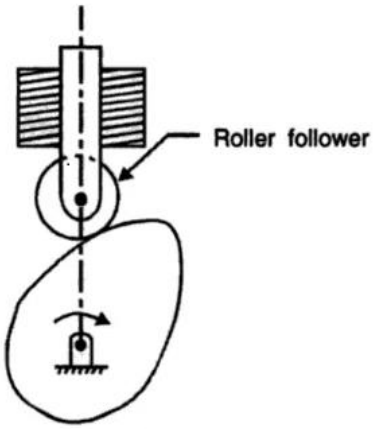
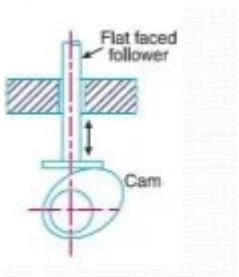
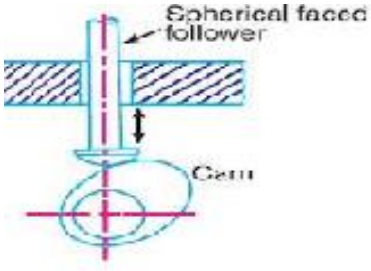
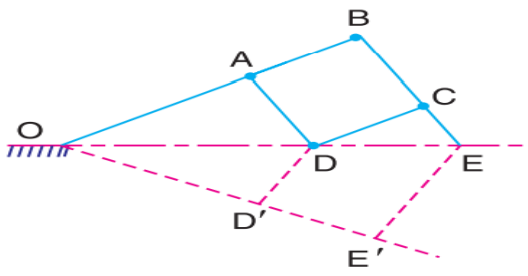
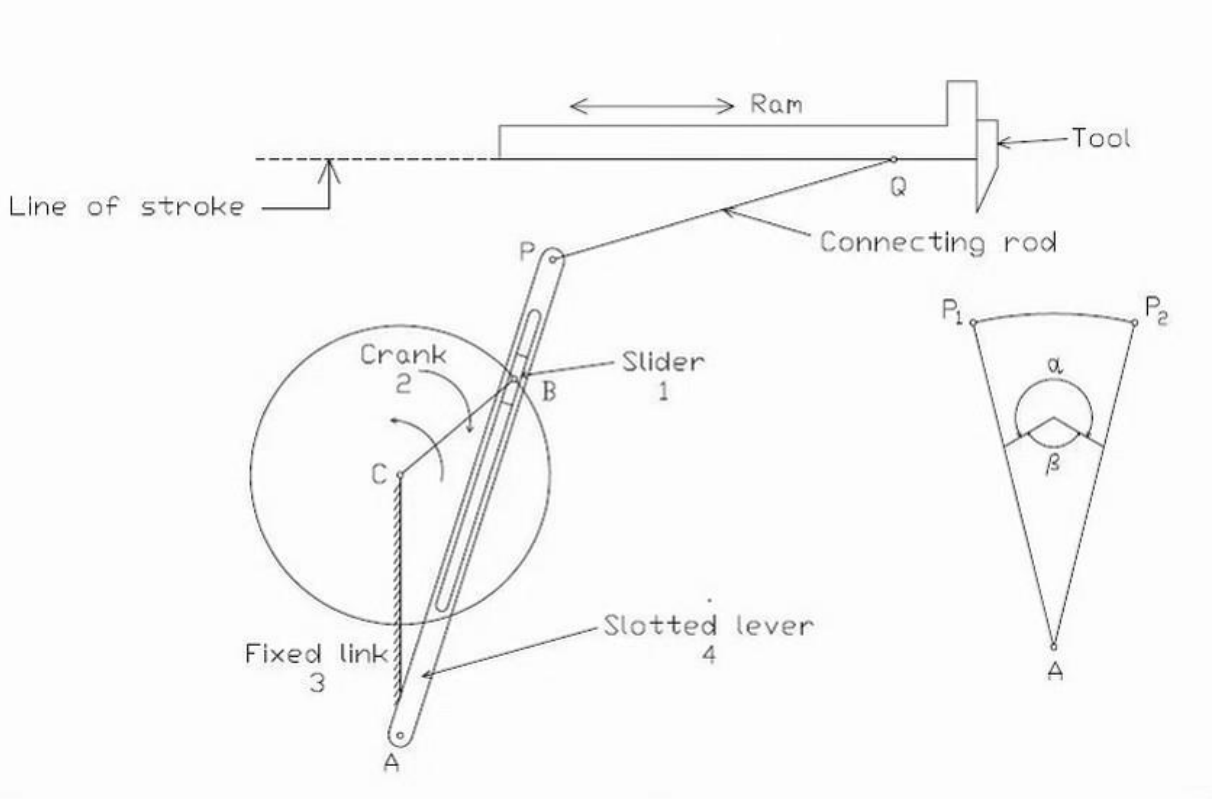
Q. No.	Sub Q. N.	Answer	Marking Scheme
1		Attempt any **FIVE (5X2)**	10
	a)	**Define(i) kinematic link -**Each part of a machine, which moves relative to some other part, is known as a ***kinematic link*** (or simply link) or ***element***. ii) The two links or elements of a machine, when in contact with each other, are said to form a pair. If the relative motion between them is completely or successfully constrained (i.e. in a definite direction), the pair is known as kinematic pair.	1 1
	b)	i) Scotch yoke mechanism ii) slider crank mechanism iii) Beam engine	1 each
	c)	V= r ω ,v= linear velocity in meter per second, r= radius in meter or length of link, ω = angular velocity in radian per second	2
	d)	**1.** Uniform velocity, **2.** Simple harmonic motion, **3.** Uniform acceleration and retardation, and **4.** Cycloidal motion.	½ each
	e)	(i) Stationary gas and oil engines and aircraft engines. (ii) valves of automobile engines	1 each
	f)	i)The brake is used to stop or slow down the rotating wheels of a vehicle where as clutch transfers power from the cars driving shaft and is used to start and stop the vehicle. ii) Brakes help in absorbing power whereas clutch is help in delivering power	02

	g)	i)Height of governor-It is the vertical distance from the centre of the ball to a point where the axes of the arms (or arms produced) intersect on the spindle axis. It is usually denoted by *h.* **ii)** *Equilibrium speed* of governor It is the speed at which the governor balls, arms etc., are in complete equilibrium and the sleeve does not tend to move upwards or downwards.	1 each
2		Attempt any THREE (3X4)	12
	a)	Elliptical trammels. It is an instrument used for drawing ellipses. This inversion is obtained by fixing the slotted plate (link 4), as shown in Fig. The fixed plate or link 4 has two straight grooves cut in it, at right angles to each other. The link 1 and link 3, are known as sliders and form sliding pairs with link 4. The link AB (link 2) is a bar which forms turning pair with links 1 and 3.When the links 1 and 3 slide along their respective grooves, any point on the link 2 such as P traces out an ellipse on the surface of link 4, as shown in Fig. 5.34 (a). A little consideration will show that AP and BP are the semi-major axis and semi-minor axis of the ellipse respectively. This can be proved as follows : Let us take OX and OY as horizontal and vertical axes and let the link BA is inclined at an angle □ with the horizontal, as shown in Fig. 5.34 (b). Now the co-ordinates of the point P on the link BA $x = PQ = AP \cos \theta$ _; and $y = PR = BP \sin \theta$ _ will be $x/AP = \cos \theta$ and $y/BP = \sin \theta$ Squaring and adding, $(x/AP)^2 + (y/BP)^2 = \cos^2 \theta + \sin^2 \theta = 1$ This is the equation of an ellipse. Hence the path traced by point *P* is an ellipse whose semi major axis is *AP* and semi-minor axis is *BP*.  	02 02

	b)	Diameter of pulley (D) = 600 mm Speed (N) = 200 RPM Coefficient of friction = 0.25 Angle of lap = 160 X π/180 = 2.792 rad (T1) Maximum tension in belt = 2500 N T1/T2= $e^{\mu\theta} = e^{0.25x2.792}$ **T1 = 2.009T2** **Maximum tension (T1) = 2.009T2** **T2 = 2500/2.009 = 1244.4 N and T1 = 2.009 X 1244.4 = 2500** **Power transmitted (P) = (T1-T2)V** **V = πDN/60 = 3.14 X 600 X 200/(1000X60) =6.283 m/sec** **P = (2500-1244.4) X 6.283 = 7889.16 watt** **Power transmitted by belt = 7.889 KW**	1 1 1 1
	c)	 i) follower  ii(Cam with roller follower   iii)Cam with flat faced follower iv) Cam with spherical faced follower	01 each

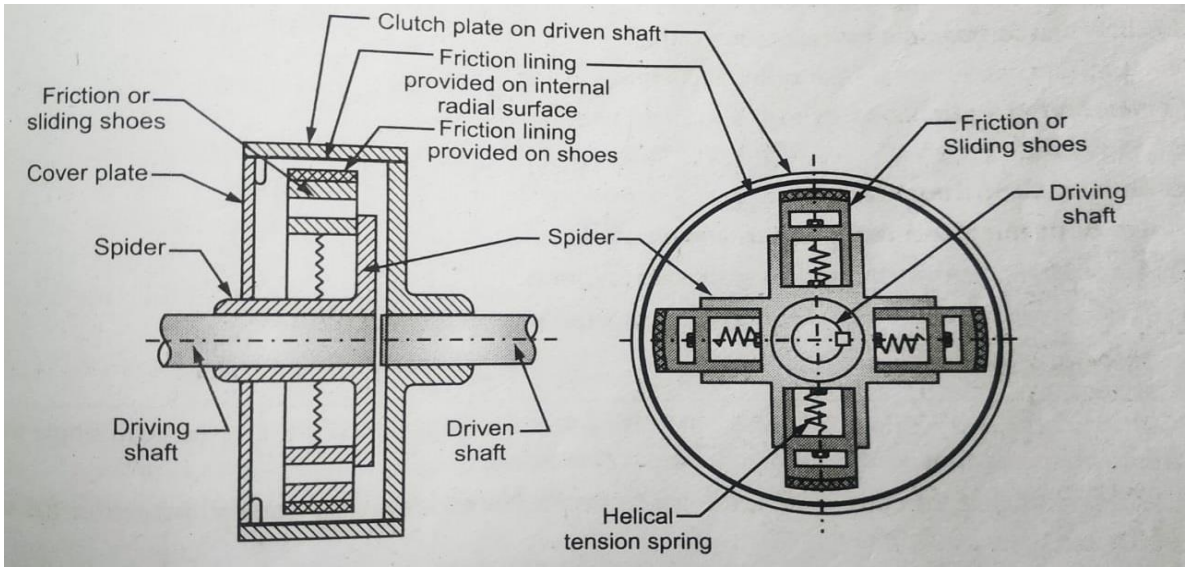
	d)	Tabular method- Let TA = Number of teeth on gear A, and TB = Number of teeth on gear B. First of all, let us suppose that the arm is fixed. Therefore the axes of both the gears are also fixed relative to each other. When the gear A makes one revolution anticlockwise, the gear B will make *TA / TB revolutions, clockwise. Assuming the anticlockwise rotation as positive and clockwise as negative, we may say that when gear A makes + 1 revolution, then the gear B will make (– TA / TB) revolutions. This statement of relative motion is entered in the first row of the table Secondly, if the gear A makes + x revolutions, then the gear B will make – x × TA / TB revolutions. This statement is entered in the second row of the table. In other words, multiply the each motion (entered in the first row) by x. Thirdly, each element of an epicyclic train is given + y revolutions and entered in the third row. Finally, the motion of each element of the gear train is added up and entered in the fourth row. * We know that NB / NA = TA/ TB. Since NA = 1 revolution, therefore NB = TA / TB.	04
3		**Attempt any THREE of the following. (3 X 4 =12)**	12
	a)	Draw a neat sketch of pantograph and explain its working. A pantograph is an instrument used to reproduce to an enlarged or a reduced scale and as exactly as possible the path described by a given point. It consists of a jointed parallelogram ABCD as shown in Fig. It consists of four turning pairs. It is inversion of four bar chain. The bars BA and BC are extended to O and E respectively, such that OA/OB = AD/BE Thus, for all relative positions of the bars, the triangles OAD and OBE are similar and the points O, D and E are in one straight line. Point E traces out the same path as described by point D. From similar triangles OAD and OBE, we find that OD/OE = AD/BE Let point O be fixed and the points D and E move to some new positions D' and E'. Then OD/OE = OD'/OE' . Similarly, if E is constrained to move in a straight line, then D will trace out a straight line parallel to the former. A pantograph is mostly used for the reproduction of plane areas and figures such as maps, plans etc., on enlarged or reduced scales. It is also used to guide cutting tools on lathe machine and milling machine, engraving machines. A modified form of pantograph is used to collect power at the top of an electric locomotive.  	02 02

	b)	Draw a neat sketch of the mechanism used in shaper machine, to achieve the quick return stroke.	04



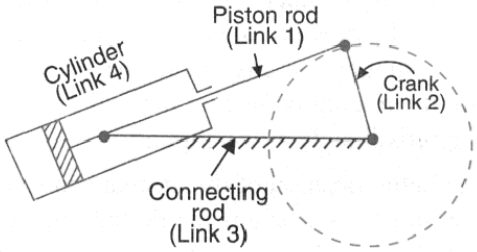
Note- sketch of Whitworth Quick return motion mechanism is also acceptable.

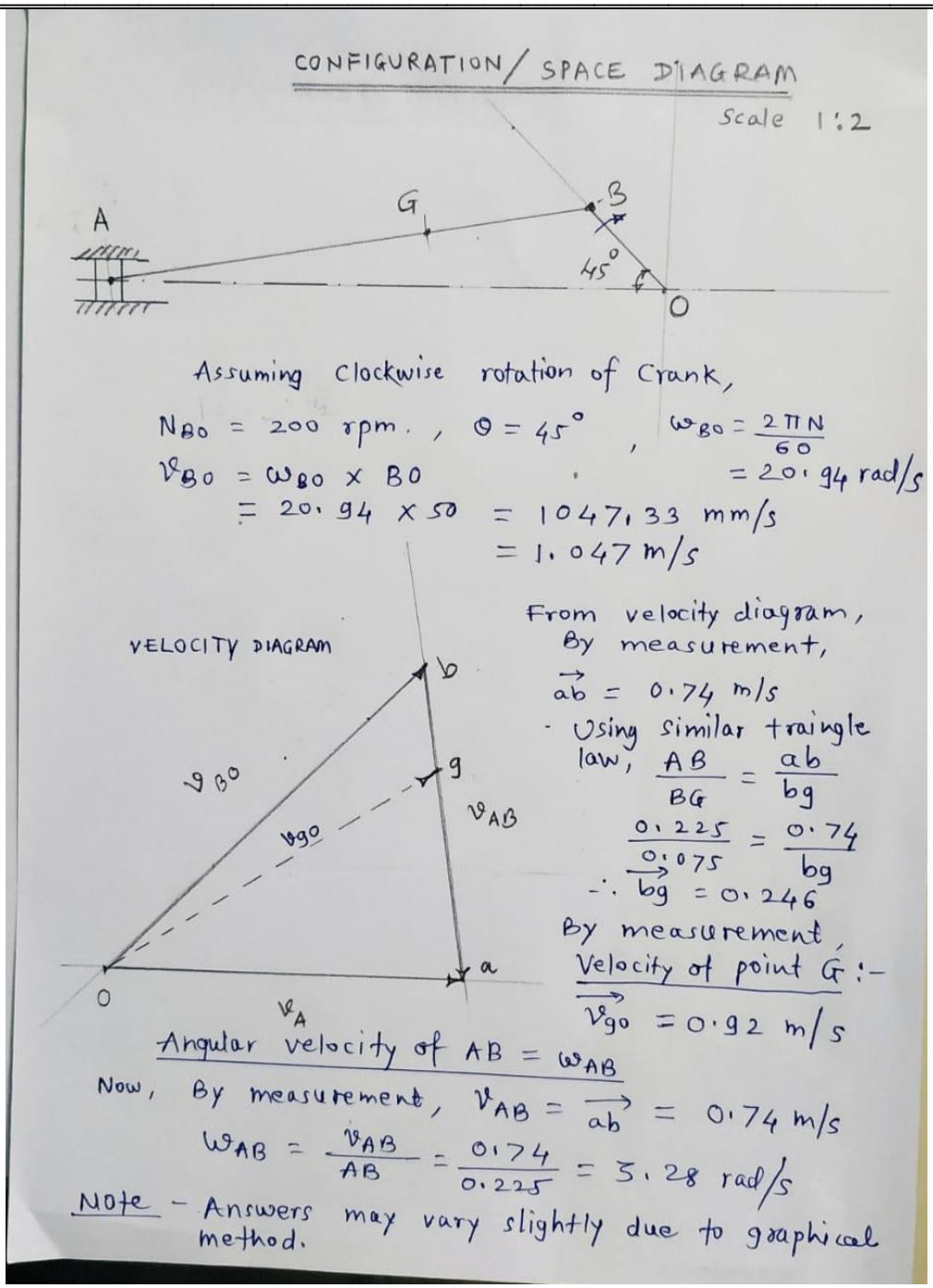
	c)	Explain the working principle of centrifugal clutch,using neat sketch.	02



The centrifugal clutches are usually incorporated into the motor pulleys. It consists of a number of shoes on the inside of a rim of the pulley, as shown in Fig. The outer surface of the shoes are covered with a friction material. These shoes, which can move radially in guides, are held against the boss (or spider) on the driving shaft by means of springs. The springs exert a radially inward force which is assumed constant. The mass of the shoe, when revolving, causes it to exert a radially outward force (i.e. centrifugal force). The magnitude of this centrifugal force depends upon the speed at which the 02

		shoe is revolving. When the centrifugal force is less than the spring force, the shoe remains in the same position as when the driving shaft was stationary, but when the centrifugal force is equal to the spring force, the shoe is just floating. When the centrifugal force exceeds the spring force, the shoe moves outward and comes into contact with the driven member and presses against it. The force with which the shoe presses against the driven member is the difference of the centrifugal force and the spring force. Using a centrifugal clutch on engine driven equipment enables the engine to be started under a no-load situation. When the engine is idling the drive remains disengaged. Only when the rpm of the engine is increased to the set engagement speed of the clutch or above will the drive be fully connected. This results in a smooth engagement .	
	d)	For high speed applications, roller follower is preferred over knife edge follower. State true or false and justify your answer. True. The fundamental justification for choosing a roller follower versus a knife-edge follower is-Due to the sliding motion of the knife-edge follower on the cam plate, there is increased friction, which causes the cam plate to wear down more quickly and requires more power to drive the cam. In case of knife edge follower there is sliding motion between the contacting surface of cam and follower. For high-speed applications, rate of wear will also increase for knife edge follower due to sliding friction and small contact area. Because of small contact area, there is excessive wear, knife edge follower is not frequently used. Whereas in roller follower there is rolling motion between contacting surfacing and more contact area, therefore rate of wear is greatly reduced	01 03
	e)	Define the term Co-efficient of fluctuation of speed, and co-efficient of fluctuation of energy as applied to flywheel. State their significance. **Co-efficient of fluctuation of speed(Cs)** -The difference between the maximum and minimum speeds during a cycle is called the maximum fluctuation of speed. The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed. Let N1 and N2 are maximum and minimum speed in rpm during cycle. N is average speed , i.e. N= (N1+N2)/2 Cs= (N1-N2)/N **co-efficient of fluctuation of energy(C_E) -** It may be defined as the ratio of the maximum fluctuation of energy to the work done per cycle. Mathematically, coefficient of fluctuation of energy, C_E =Maximum fluctuation of energy/ Work done per cycle The work done per cycle (in N-m or joules) may be obtained by using the following relation: Work done per cycle = $T_{mean} \times \theta$ where T_{mean} = Mean torque, and θ = Angle turned (in radians), in one revolution. = 2π, in case of steam engine and two stroke internal combustion engines = 4π, in case of four stroke internal combustion engines. Significance- The coefficient of fluctuation of speed is a limiting factor in the design of flywheel. It varies depending upon the nature of service to which the flywheel is employed. Coefficient of fluctuation of energy guides us for selection of engine for particular application. E. g. whether to go for single cylinder/multicylinder engine/ four stroke/two stroke engines	1 1 2

4		**Attempt any TWO of the following. (2 X6 =12)**	12
	a)	Draw a neat sketch of oscillating cylinder engine and explain its construction.	
			2
		inks and their motions - Connecting rod (link 3) - Fixed Crank (Link 2) -Rotating Piston and rod (link 1)- Reciprocating Cylinder (link 4)- Oscillating	1
		Pairs - Turning – Crank and Connecting rod Turning – Crank & piston rod Sliding – Piston rod & Cylinder. Turning – Cylinder and connecting rod	1
		Construction – This mechanism is an inversion of Single slider crank chain, which is obtained by fixing connecting rod. It has three turning pairs & one Sliding pair. As shown in figure, both rod & piston form one link. There is no relative motion between rod &Piston. The cylinder is pivoted to frame, due to which whole cylinder is free to oscillate about the frame.The mechanism is used where rotary motion is converted into oscillating motion. It is used in printing press machine.	2
	B)	In the engine mechanism, crank OB=50 mm, length of connecting rod = 225 mm.The Centre of gravity of the rod is at 'G' which is 75 mm from 'B'. The speed is 200 rpm, and the crank OB is rotated at 45°from 'OA'. Find out the velocity of point 'G' and angular velocity of AB by relative velocity method.	



2

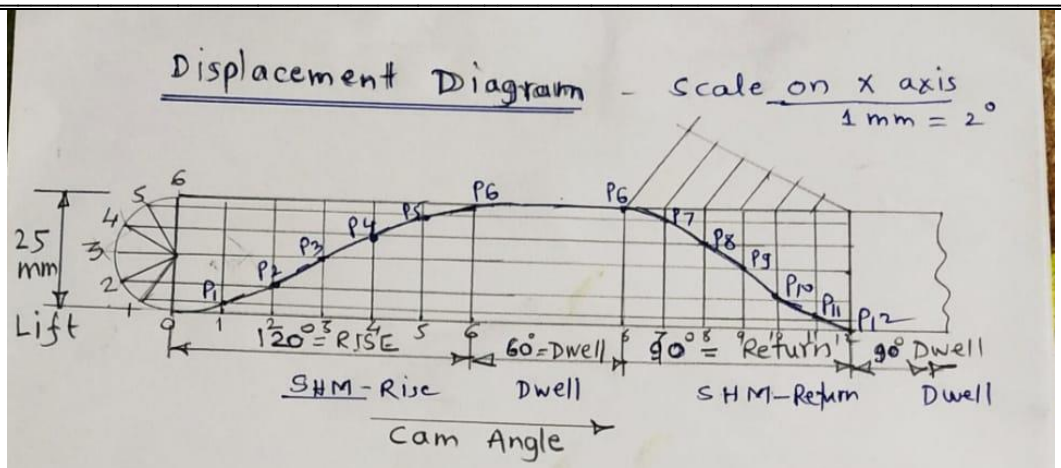
2

1

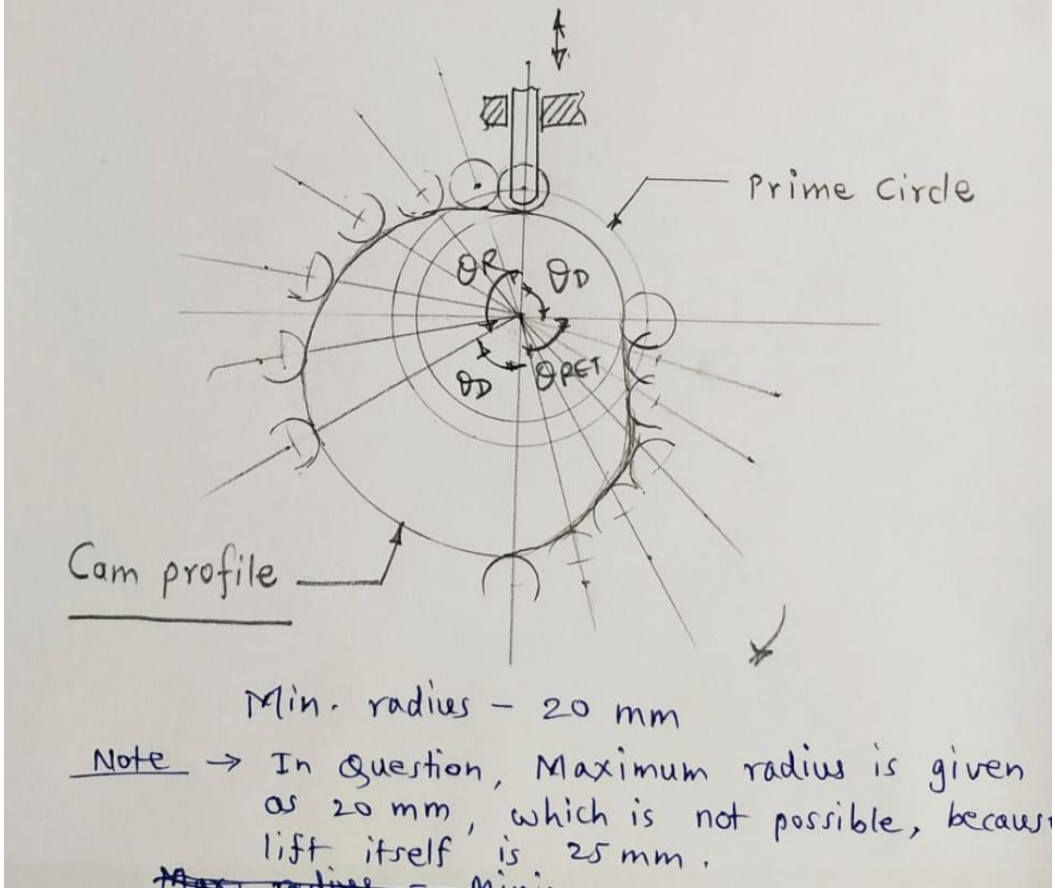
1

C) A disc cam rotating in a clockwise direction is used to move a reciprocating roller with simple Harmonic Motion in a radial path, as given below
(i) Outstroke with maxi. displacement of 25 mm during 120° of camrotation
(ii) Dwell for 60° of cam rotation
(iii) Return stroke with maxi displacement of 25 mm during 90° of camrotation, and dwell for remaining period.
Draw the cam profile, when the maximum cam radius is 20 mm. Take roller diameter as 8 mm.

3



3



Min. radius – 20 mm

Note → In Question, Maximum radius is given as 20 mm, which is not possible, because lift itself is 25 mm.

5		Attempt any **TWO** of following	12
	a)		1 mark each

Sr. No.	Application	Power Transmission and Justification
I.	Electric Two Wheeler (Battery Operated)	For Starting V belt drive, For transmission of power Controller
II.	Floor Mill	Flat/ V belt, Constant Velocity ratio; compact
III.	JCB Wrist Watch	Mechanical drive (Gear Drive) / Hydraulic drive
IV.	Wrist watch	Gear drive, Constant Velocity ratio; Accuracy
V.	Stone crusher	Gear drive; Speed Reduction, more torque
VI.	Road Roller	Mechanical (Gear drive) / Hydraulic Drive with Gear (New Machines) .Speed Reduction, more torque.

b)

Given :

Crank radius; r = 200 mm = 0.2 m; Length of connecting rod; l = 800 mm = 0.8 m;

Rotational Speed; N = 500 RPM; Angular speed ω = (2πN)/60= (2 X 3.14 X 500)/60 = 52.33 rad/sec; Obliquity ratio; n= l/r =0.8/0.2 =4 — 03

Crank Angle (θ)= 60^0

Velocity of Piston $V_P = \omega * r(\sin\theta + \frac{\sin 2\theta}{2*n})$

$52.33*0.2*\left(\sin 60 + \frac{\sin 120}{2*4}\right) = 10.46*\left(0.866 + \frac{0.866}{8}\right) =$ **10.190 m/sec** — 03

Velocity of Piston = 10.190 m/sec

Acceleration of Piston

$$\alpha_P = \omega^2 * r(\cos\theta + \frac{\cos 2\theta}{n})$$

$$52.33^2 * 0.2 * \left(\cos 60 + \frac{\cos 120}{4}\right) = 2738.0 * 0.2 * \left(0.5 + \frac{-0.5}{4}\right) = 205.35 \text{ m/sec2}$$

Acceleration of Piston= 205.35 m/sec²

c)

Solution.

a) Analytical method

The magnitude and direction of the balancing mass may be obtained, analytically, as discussed below : Resolve the centrifugal forces horizontally and vertically and find their

sums,i.e.

$\Sigma H = m_1 . r_1 \cos\theta_1 + m_2 . r_2 \cos\theta_2 + \ldots\ldots$

$\Sigma V = m_1 . r_1 \sin\theta_1 + m_2 . r_2 \sin\theta_2 + \ldots\ldots$

Magnitude of the resultant centrifugal force,

$$F_C = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$$

If θ is the angle, which the resultant force makes with the horizontal, then

$$\tan\theta = \frac{\Sigma V}{\Sigma H}$$

Given : 01

$m_1 = 12$ kg ; $m_2 = 15$ kg ; $m_3 = 18$kg ; $m_4 = 20$ kg ;

$r_1 = 0.04$ m ; $r_2 = 0.05$ m ; $r_3 = 0.06$ m ; $r_4 = 0.03$ m ;

$\theta_1 = 0°$; $\theta_2 = 60°$; $\theta_3 = 135°$; $\theta 4 = 270°$;

Balance mass radius $r = 0.1$ m

Since the magnitude of centrifugal forces are proportional to the product of each mass and its radius, therefore 02

$m_1 r_1 = 12 \times 0.04 = 0.48$ kg-m;

$m_2 r_2 = 15 \times 0.05 = 0.75$ kg-m;

$m_3 r_3 = 18 \times 0.06 = 1.08$ kg-m; 02

$m_4 r_4 = 20 \times 0.03 = 0.6$ kg-m

$\Sigma H = 0.48\cos0 + 0.75\cos60 + 1.08\cos135 + 0.6\cos270 = 0.0914$ kg.m

$\Sigma V = 0.48\sin0 + 0.75\sin60 + 1.08\sin135 + 0.6\sin270 = 0.8131$ kg.m 01

$F_C = \sqrt{(0.0914)^2 + (0.8131)^2} = 0.8181$ kg.m;

$\therefore F_C = m . r$,

$0.8181 = 0.1 \times m$; **m = 8.181 kg Ans**

$\tan\theta = \frac{\Sigma V}{\Sigma H} = 0.8131 / 0.0914 = 8.90$ $\theta = 1.85^0$

θ = 90°- 1.85° = 88.15°

or

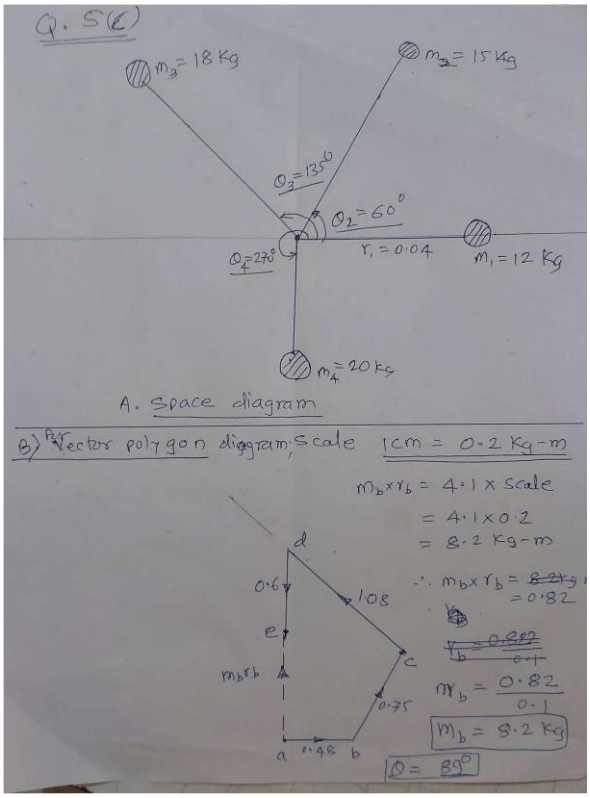
b) Graphical Method

$m_1 r_1 = 12 \times 0.04 = 0.48$ kg-m;

$m_2 r_2 = 15 \times 0.05 = 0.75$ kg-m;

$m_3 r_3 = 18 \times 0.06 = 1.08$ kg-m;

$m_4 r_4 = 20 \times 0.03 = 0.6$ kg-m



6 Attempt any TWO of following 12

a) Need of Chain lubrication

To reduce friction and wear between various parts of chain as links rollers bushes and sprockets. 02

- To remove wear particles, foreign particles etc.
- To increase power transmission.
- To reduce maintenance cost.
- To increase life of system. 01

Various methods of chain Lubrication.

1. Manual Lubrication.
2. Drip Lubrication
3. Oil bath lubrication 03

Manual lubrication- In this lubrication the oil is applied to elements of chain and sprocket. The oil is applied through brush or cotton. The frequency of lubrication is decided depending upon the use of chain drive . It may be daily; after shift or some two or three days, week.

Drip Lubrication - In this lubrication the oil is dripped on elements of chain and sprocket. The drip speed is decided depending on application and speed of chain. A drip pipe or system is used.

Oil bath lubrication - In this lubrication the oil is applied inserting some part of chain in oil bath. The oil bath is always maintained at particular level.

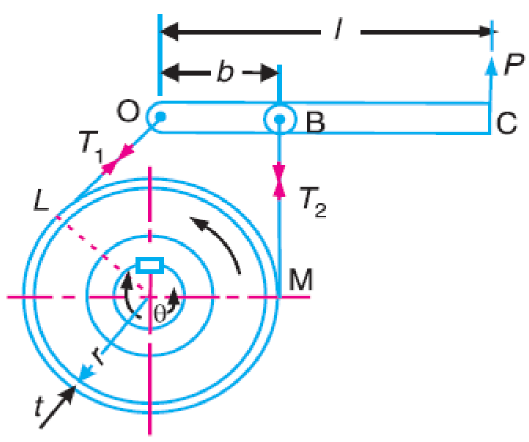
b) Given :

d = 450 mm or r = 225 mm = 0.225 m ; T_B = 225 N-m ; b = OB = 100 mm = 0.1 m ;

l = 500 mm = 0.5 m ; μ = 0.25

Let P = Operating force.

Operating force when drum rotates in anticlockwise direction 02



We know that angle of wrap, θ = 360 X ¾ = 270 X π/180 = 4.713 Rad. 02

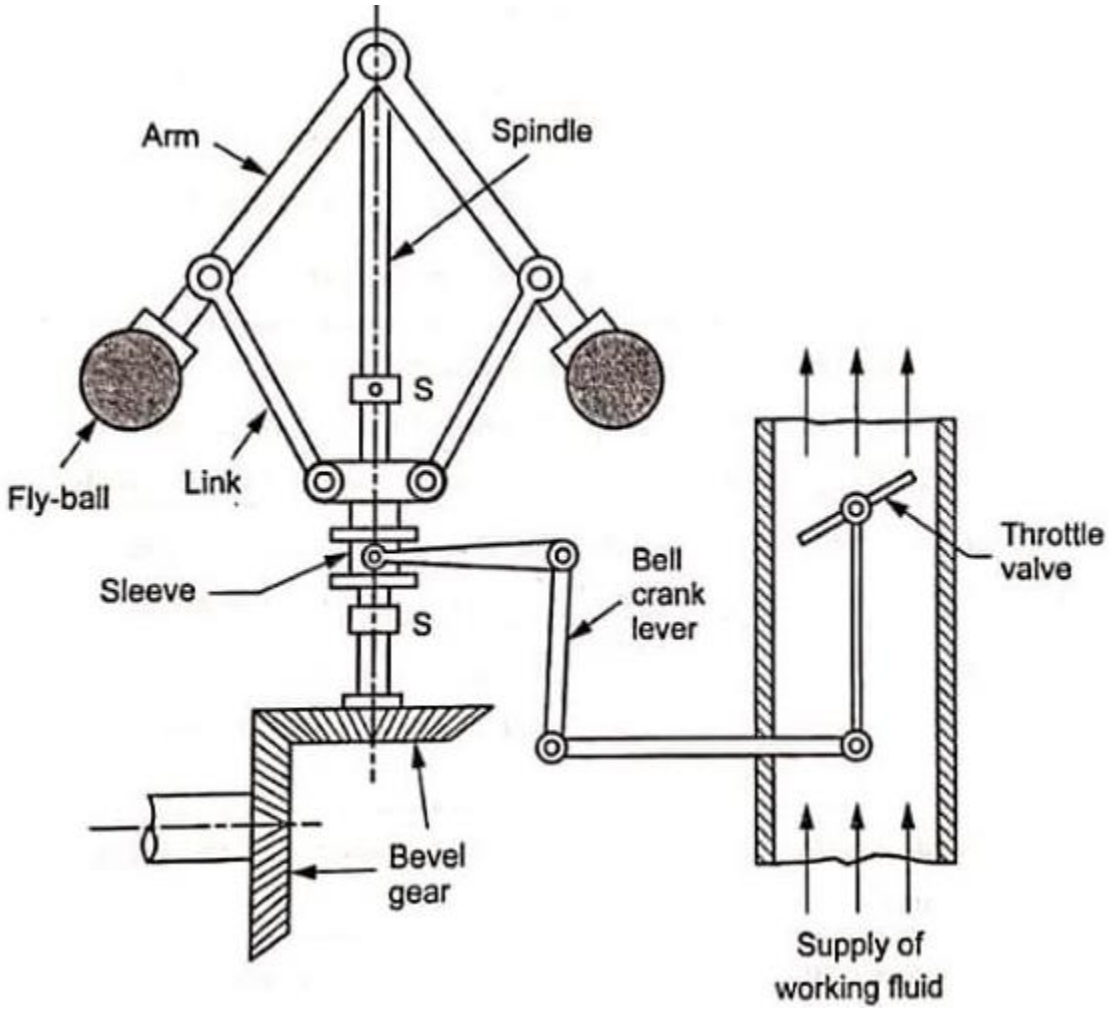
$$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25x4.713} = 3.253$$

-- 1

We know that braking torque (TB),

$T_B = (T_1 - T_2)\ r$

$225 = (T_1 - T_2)\ 0.225$

		$(T_1 - T_2) = 225/0.225 = 1000N$ ---------- 2 From equations **1** and **2,** we have $T_1 = 1444$ N; and $T_2 = 444$ N Now taking moments about the fulcrum O, we have $P \times l = T_2.b$ Or $P \times 0.5 = 444 \times 0.1 = 44.4$ $P = 44.4 / 0.5$ **P = 88.8 N**	01 01
	c)	 **Working** The centrifugal governors are based on the balancing of centrifugal force on the rotating balls by an equal and opposite radial force. When the load on the engine decreases, the engine and the governor speed increases. This increases the centrifugal force acting on the balls and the balls move radially outwards. Therefore the sleeve rises upwards. This upward movement of the sleeve reduces the supply of the working fluid and hence the speed is decreased. Thus the engine speed falls and comes near about the mean speed.	02+01 label 03

		Similarly, when the load increases, the speed of the engine and the governor decreases. This results in the decrease of centrifugal force on the balls. Hence the balls move inwards and the sleeve moves downwards. The downward movement of the sleeve increases the supply of the working fluid and hence the speed is increased. Thus the engine speed rises and comes near about the mean speed.	
		END	

22438

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **12**

(a) Define : (i) Kinematic link (ii) Kinematic pair.

(b) Name any two mechanisms used to convert rotary motion into reciprocating motion.

(c) State the inter-relation between linear velocity and angular velocity.

(d) Name the four motions by which follower moves, during its applications.

(e) State the applications of roller follower and flat faced follower.

(f) State how the function of a brake is different than clutch.

(g) Define : (i) Height of governor (ii) Equilibrium speed of governor.

2. Attempt any THREE of the following : **12**

(a) Draw a neat sketch of Elliptical trammel, and explain its working principle.

(b) Find the power transmitted by a belt running over a pulley of 600 mm diameter at 200 rpm. The co-efficient of friction between the belt and the pulley is 0.25, angle of lap is 165°, and maximum tension in the belt is 2550 N.

(c) Draw the schematics of the following :

(i) Cam with knife edge follower

(ii) Cam with roller follower

(iii) Cam with flat faced follower

(iv) Cam with spherical faced follower.

(d) Explain how the velocity ratio of epicyclic gear train is obtained by tabular method.

3. Attempt any THREE of the following : **12**

(a) Draw a need sketch of pantograph and explain its working.

(b) Draw a neat sketch of the mechanism used in shaper machine, to achieve the quick return stroke.

(c) Explain the working principle of centrifugal clutch, using neat sketch.

(d) For high speed applications, roller follower is preferred over knife edge follower. State true or false and justify your answer.

(e) Define the term co-efficient of fluctuation of speed, and co-efficient of fluctuation of energy as applied to flywheel. State their significance.

4. Attempt any TWO of the following : **12**

(a) Draw a neat sketch of oscillating cylinder engine and explain its construction.

(b) In the engine mechanism, crank OB = 50 mm, length of connecting rod = 225 mm. The centre of gravity of the rod is at 'G' which is 75 mm from 'B'. The speed is 200 rpm, and the crank OB is rotated at 45° from 'OA'. Find out the velocity of point 'G' and angular velocity of AB by relative velocity method.

(c) A disc cam rotating in a clockwise direction is used to move a reciprocating roller with simple Harmonic Motion in a radial path, as given below

(i) Outstroke with maxi. displacement of 25 mm during 120° of cam rotation

(ii) Dwell for 60° of cam rotation

(iii) Return stroke with maxi displacement of 25 mm during 90° of cam rotation, and dwell for remaining period.

Draw the cam profile, when the maximum cam radius is 20 mm. Take roller dia. meter as 8 mm.

5. Attempt any TWO of the following : **12**

(a) Applying the knowledge of selection of drive for power transmission, select the suitable drive for following applications. Also justify your selection.

(i) Electric Two Wheeler (Battery operated)

(ii) Flour Mill

(iii) JCB (Heavy earth moving machine)

(iv) Wrist watch (Analog)

(v) Stone crusher

(vi) Road Roller

(b) In a slider crank mechanism, the length of crank and connecting rod are 200 mm and 800 mm respectively. The crank position is at the 60° from I.D.C. The crank rotates at a speed of 500 rpm (clockwise). Using analytical method, determine the velocity and acceleration of slider.

(c) Four masses A, B, C & D are attached to the shaft and revolve in the same plane. The masses are 12 kg, 15 kg, 18 kg, & 20 kg respectively and their radii of rotation are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B, C and D are 60°, 135° and 270° from mass A. Find the magnitude and position of the balancing mass at radius of 100 mm.

6. Attempt any TWO of the following : **12**

(a) State the need of chain lubrication and explain various methods of chain lubrication.

(b) A band brake acts on ¾th of the circumference of a drum of 450 mm diameter which is keyed to the shaft. The band brake provides a braking torque of 225 N.m. one end of the band is attached to a fulcrum pin of the lever and other end to a pin 100 mm from the fulcrum. If the operating force is applied at 500 mm from the fulcrum and the co-efficient of friction is 0.25 find the operating force when the drum rotates in the anti-clockwise direction.

(c) Using neat sketch explain the working of centrifugal governors.

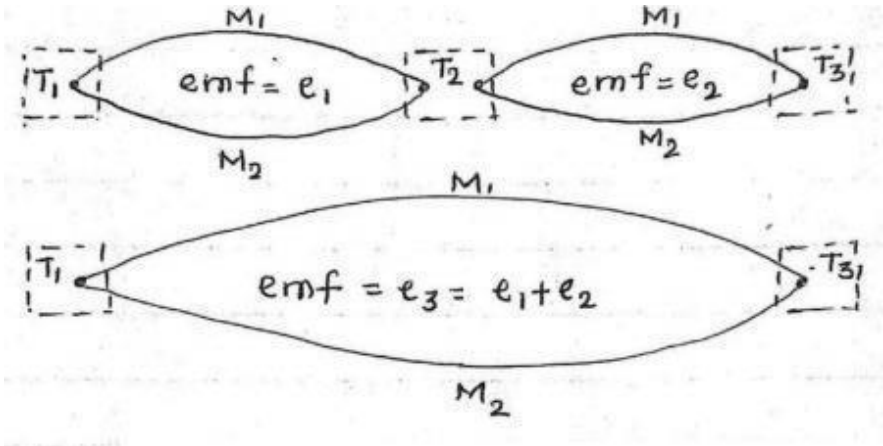
SUMMER – 2022 EXAMINATION

Subject Name: Mechanical Engineering Measurement **Model Answer** **Subject Code:** 22443

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE**	**5 X 2 = 10**
	(a)	**State the working principle of RVDT**	
	ANS	This is called as Rotary Variable Differential Transformer (RVDT) and is used for measurement of angular displacement. Iron core is having angular motion and is having windings. Two secondary and one primary winding is used in RVDT. Input supply is given to primary winding and output is taken across secondary winding. Output is the difference of voltage across two secondary windings. This output depends on the movement of central iron cores angular displacement.	**2 Mark**
	(b)	**Name different Torque Measuring Instruments**.	
	ANS	i) Inline Torque Measurement ii) Reaction Torque Measurement iii) Slip Ring iv) Rotary Transformer	**2 Mark for any four points**

		v) Infrared Sensor vi) FM Transmitter	
	(c) **ANS**	**State the law of Intermediate Temperature.** If a simple thermocouple circuit develops an emf e1, when its junctions are at temperature T1 and T2, and an emf e2 when its junctions are at temperature T2 and T3, it will develop an emf e1 + e2 when its junctions are at temperature T1 and T3.  **Figure: Law of Intermediate Temperature**	**1Mark for Statement** **1 Mark for Fig.**
	(d) **ANS**	**Enlist types of flow meters**. i) Orifice meter ii) Venturi meter iii) Rotameter iv) Hot wire Anemometer v) Hot film Anemometer vi) Electromagnetic Flowmeter vii) Ultrasonic Flowmeter. viii) Turbine flow meter.	**2Marks for Any four types.**

		ix) Vortex shedding Flow meter.	
	(e) **ANS**	**Define term Natural Frequency.** The frequency at which a system tends to oscillate in the absence of any driving or damping force is called as Natural Frequency.	**2 Marks**
	(f) **ANS**	**Enlist types of speed measurement devices.** i) Mechanical Counter ii) Revolution counter. iii) Tachoscope iv) Mechanical Tachometer (Hand Speed Indicator) v) Slip-Ring Clutch Tachometer vi) Centrifugal-Force Tachometer vii) Vibrating Read Tachometer. viii) Electrical Tachometer:- D.C. or A.C. tachometer generator ix) Photoelectric tachometer x) Toothed rotor Variable Reluctance Tachometer. xi) Stroboscopic tachometer.	**2Marks for any four types.**
	(g) **ANS**	**List desirable characteristics for force measuring sensor.** i) Nominal Force ii) Sensitivity iii) Zero signal iv) Nominal displacement v) Stiffness vi) Fundamental frequency	**2 Marks for any four types.**

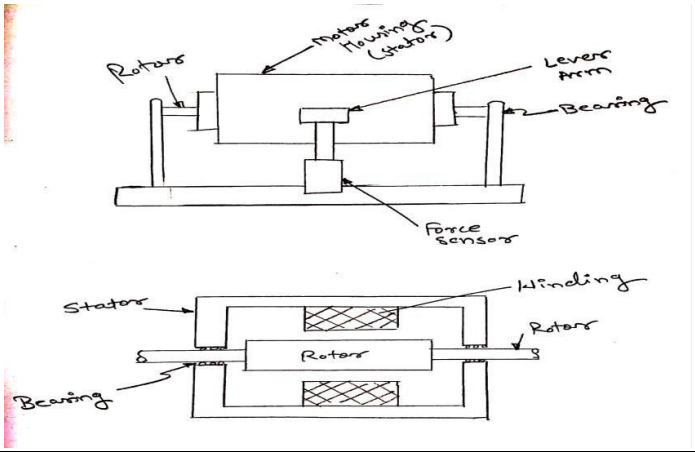
2		**Attempt any THREE**	**3 X 4 = 12**
	(a)	**Differentiate between Accuracy and Precision.**	**Any 04 difference (01 mark each)**

Accuracy	Precision
It is the closeness with which an instrument reading approaches to the true value of the quantity being measured.	It is the degree of reproducibility among several independent reading of the same true value under specified condition.
It is expressed as the limit of error of a measuring device	It is composed of two characteristics, conformity and no of significant digits
Accuracy of measurement means conformity of the truth.	Precision refers to degree of agreement within group of measurement.
Expressed on the basis of % actual scale or full scale reading. Accuracy necessarily is with precision	Precision in measurement does not guaranty accuracy
Measurements are dependent on the systematic errors	Measurements are dependent on the random errors.
Determined by proper calibration	Determined by statistical analysis.

(b) **Explain working principle of Slip Ring with neat sketch.**

ANS The principle is based on torsion part of shaft and its torsion. Measurement of torsion of the shaft is possible in several ways. For a torque measurement we must place these strain gauge in this way. For pressure, tension and bending measurement the position of strain gauges are different for the transfer of the signal from moving rotor to stator terminals the slip rings are used in this way the signal is partly interfered. It is also possible to use instead of slip rings the special contacts with mercury or contactless telemetry datatransfer.

2 Marks for Explanation



2 Marks for Fig.

(c) **Compare Radiation and Optical Pyrometer**.

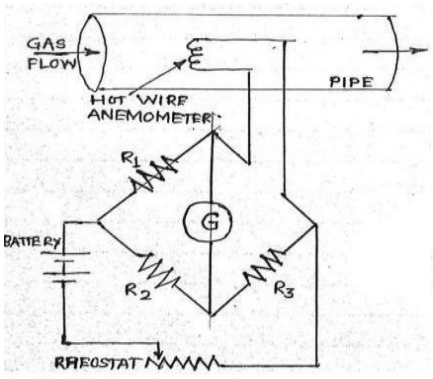
ANS

Radiation pyrometer	Optical Pyrometer
Temp Range: 15° C to 3000° C	Temp Range: 700 to 4000° C
Sensitivity is fair	Sensitivity is good
Calibration by comparing with standard optical pyrometer.	Calibration against standard tungsten strip lamp
All radiations are considered	Monochromatic radiation
More Accurate	Comparatively less Accurate

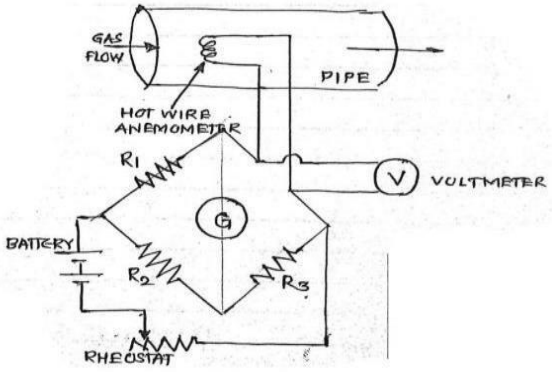
Any 4 Pts (1 Mark for each)

(d)

Explain the working of Hot Wire Anemometer.



Constant Current Method



Constant Temperature Method

2 Marks for Fig.

Hot wire anemometer measure the mean and fluctuating flow of **gases**. The sensor is a 5 micron diameter platinum-tungsten wire welded between the two prongs. This wire heated electrically as part of a wheat-stone bridge circuit. When the probe is introduced into the flowing fluid, it tends to be cooled by instantaneous velocity. So, tendency for the electrical resistance to diminish.

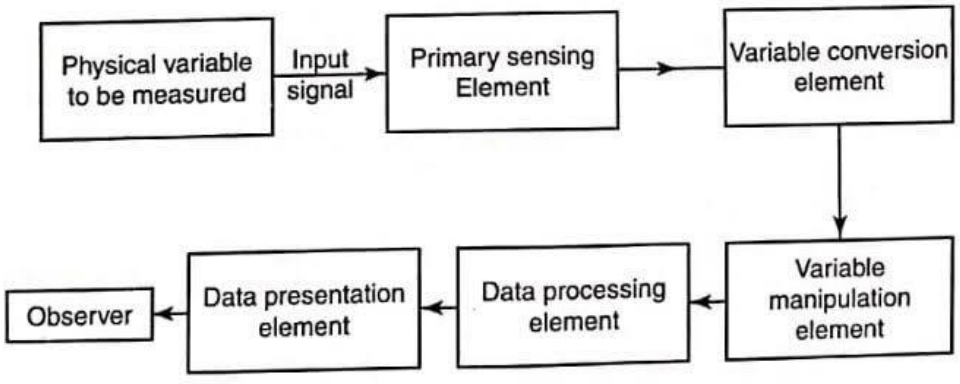
The rate of cooling of wire depends upon the -

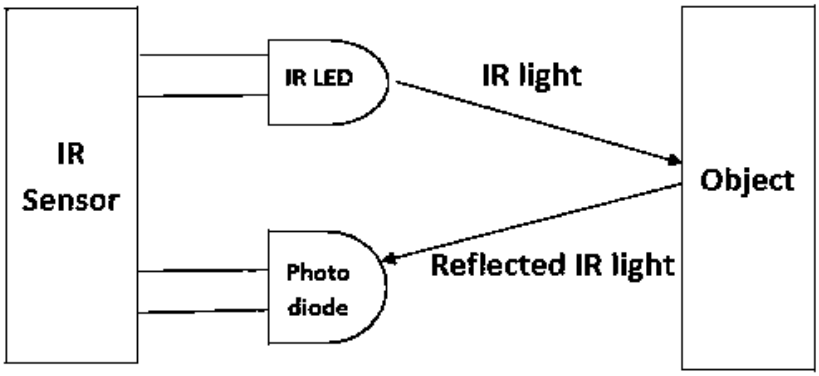
- → Dimension and physical properties of wire
- → Diff. of the temp. between wire and the fluid
- → Physical properties of the fluid
- → Stream velocity under measurement

2 Marks for Explanation

First three conditions are effectively constant and the instrument response is then a directmeasurement of the velocity change.
Depending on the electronic equipment, hot wire may be operated in two ways;

- → Constant current mode:

		→ Constant temperature mode: **Constant current mode:** The heating current i.e. voltage across the bridge is kept constant. Initially the circuit is adjusted such that the galvanometer reads zero when the heated wirelies in stationary air. When the air flows, the hot wire cools and resistance changes and the galvanometerdeflects. The galvanometer deflection are amplified, measured and correlated with air velocity **Constant temperature mode:** Temperature of filament is kept constant. Hot wire loses heat (decreases temperature) by the flowing fluid. The external bridge voltage is applied to the wire to maintain a sensibly constant temp. The bridge voltage is varied so as to bring the galvanometer needle to zero. The reading on the voltmeter is recorded and correlated with air velocity.	
3		**Attempt any THREE**	
	(a)	**Explain term drift and sensitivity.** **Drift**: Drift is an undesired gradual departure of instrument output over a period of time that is not related to change inputs or load. It is nothing but undesired reading shown by instrument. Factors responsible to cause drift such as long time uses without calibration, friction and environmental factors. **Sensitivity** : It is define as the faster response given by instrument after changing input. It is the ratio of the magnitude of output signal to the magnitude of input signal. Represented by (K). K = Change in output signal / Change in Input signal	**3 X 4 = 12** 2 marks 2 marks
	(b)	**Draw block diagram of generalized measurement system**  	4 marks for fig.

	(c)	**Explain infra-red sensor with neat sketch**
		 
		○ Infra Red (IR) sensor is an electronic device that emits the light in order to sense some objects of the surrounding.
		○ An IR sensor can measure the heat of an object as well as detects the motion.
		○ The radiations are invisible to our eyes but IR sensors can detects these radiations.
		○ IR sensors available in two types
		  ○ Active IR sensor and
		  ○ Passive IR sensor
		○ An IR sensor consist of an IR LED and IR photodiode
		○ Infrared LED emits infrared radiations and infrared photodiode detects the radiation from an IR LED
		○ When the IR transmitter emits radiation it reaches the object and some of the radiation reflects back to the IR receiver based on the intensity of the reception by the IR receiver the output of the sensor defines.
			2 marks for fig.
			
			2 marks

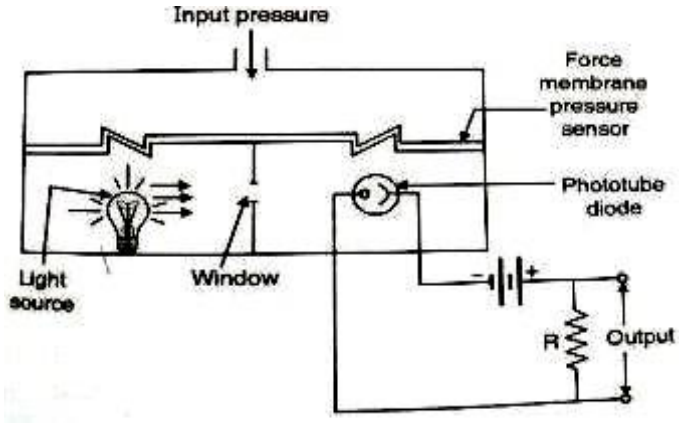
	(d)	**Explain working principle of Photo electric pressure transducer with sketch**. **Photoelectric pressure transducer** 	2 marks for fig.

Figure: Photoelectric pressure transducer

It consist of port for input pressure ,Pressure sensing member like diaphragm ,light source a small window, a photo tube with output circuit. The function of pressure sensing element is to control the aperture of small window. The amount of output is entirely depends upon the amount of incident light falling on phototube. When the pressure to be measured is applied through port to the pressure sensing member, it changes the positionof window. As the light source and phototube are separated by a window it changes the amount of light falling on phototube, causing change in the current. This change in currentis approximately linear with displacement of window i.e applied pressure. The current in phototube is amplified by a suitable output circuit. A meter connected across output terminal can directly calibrate in terms of pressure measurement. An A.C Modulated light or stable source of light can be used for incident light.

2 marks

Advantages:

1. It can measure both static & dynamic pressure.
2. It is highly efficient
3. Easy portability
4. Compact size.

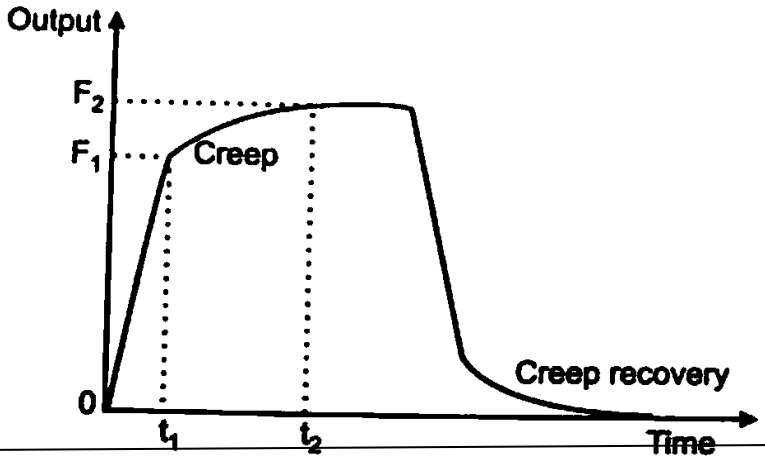
4. **Attempt any THREE** **3 X 4 = 12**

(a) **Draw creep curve for force transducer.**

Creep of a force transducer is usually define as the change of output with time following a step increase in force from one value to another

4 marks

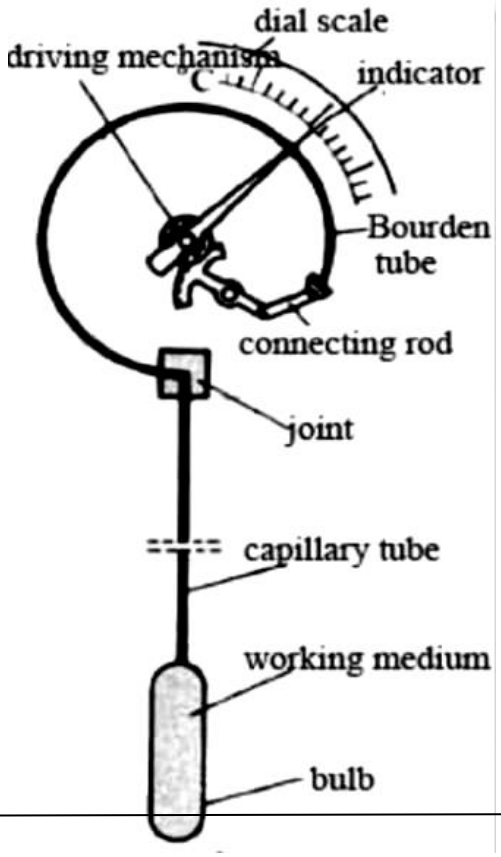
For fig.

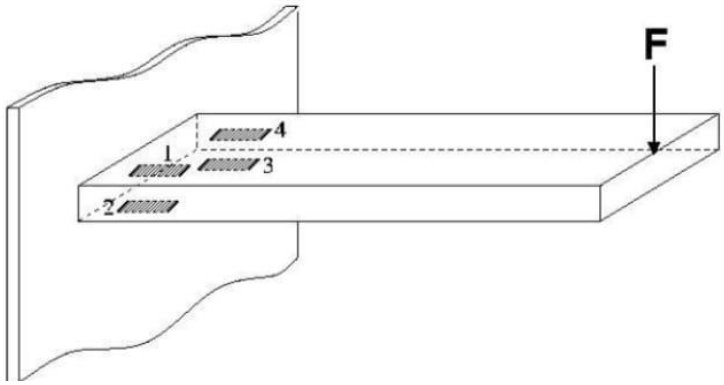


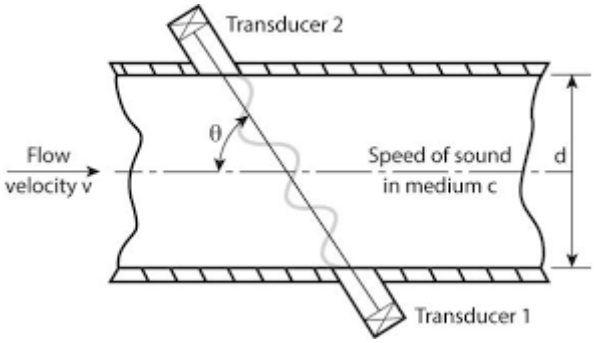
(b) **Enlist any four applications of Optical pyrometer.**

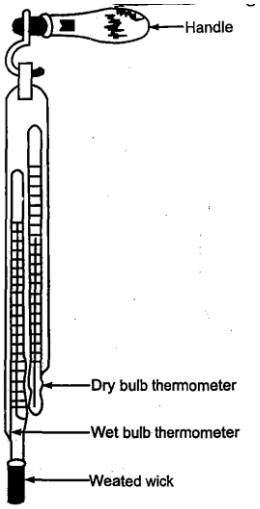
4 marks for four Applica

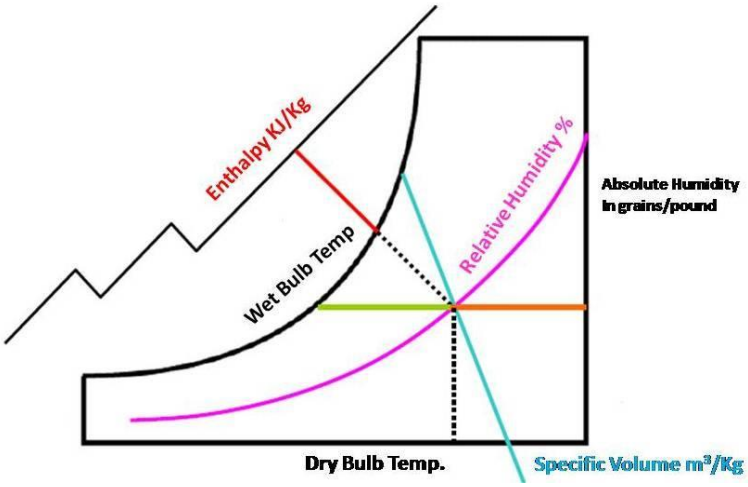
1. It is useful to measure furnace temperature.

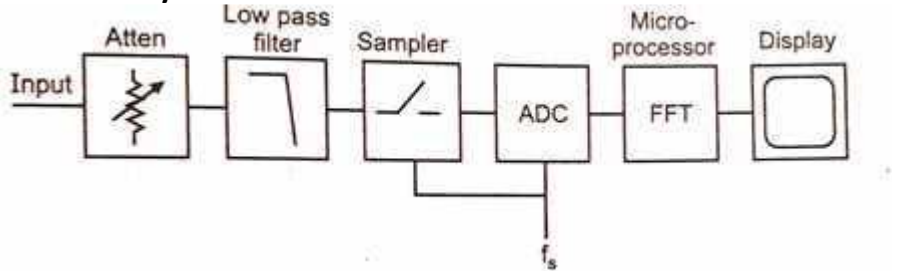
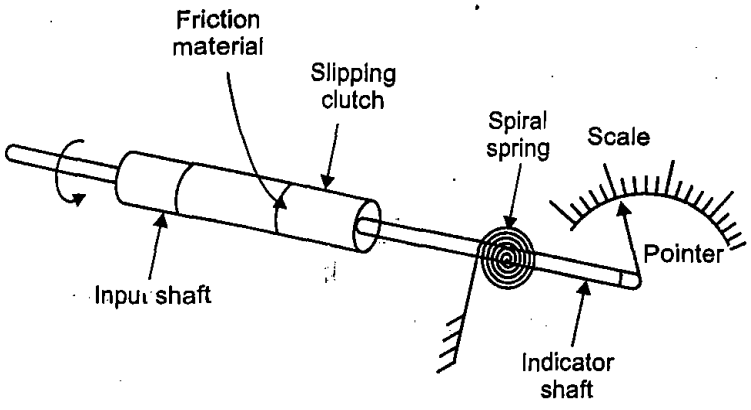
		2. It is used to measure the temperature of highly heated materials. 3. It is used to measure temperature of molten metal in heat treatment processes 4. It is used in steel industries, plastic industries, glass manufacturing etc. 5. It is used in critical process measurements of semi conductor, induction heat treating, crystal growth, medical etc. It is used in graphite rod manufacturing industry	**-tions**
	(c)	**Draw labeled diagram of Pressure Thermometer**  	2marks for fig. 2 Marks for labeled.
	(d)	**`Explain the procedure of strain measurement of cantilever beam** Strain measurement of cantilever beam o Measuring the strain in cantilever beam can be done through the use of four resistance strain gauges. o 2 strain gauges mounted on top of the beam and two mounted below. o Static load will be incremented at different locations along the beam to produce measurable strains. o In many applications strain gauges are used with Wheatstone bridge circuit which consists of four resistors in an electrical circuit. o As the load is subjected to cantilever beam the strain get induced in the beam also the strain gauges get stretch tensile stress get developed resulting in change in resistance.	2 Marks for Explanation

		○ The Wheatstone bridge circuit get unbalance due to change in resistance ○ This change in resistance is calculated and can be taken as strain of the cantilever beam. ○ With every increasing load the value of strain get changed.  Fig. Cantilever beam with four strain gauges	2marks for fig.
	(e)	**Write sound level norms as per API** Four cylinder IC engine - 70-80 dB Centrifugal pump - 80-85 dB Lathe machine - 70-85 dB Industrial exhaust fan - 85 dB	4 marks 1 mark for each
5.		**Attempt any TWO**	**2 X 6 = 12**
	(a)	**Write two application of following** **i) Contact Transducer** : • Hand Tachometer is used for speed measurement of rotating member • Thermometer is used to measure temperature • Burdon tube pressure gauge is used to measure pressure • veturimeter is used to measure flow of fluid ii **) Active transducer**: • Piezoelectric transducer is used to measure pressure, strain, torque etc. • Dial Indicator is used for surface roughness, calibration, displacement etc.	**2 Marks** **(Any Two)** **2Marks** **(Any Two)**

		• mercury thermometer to measure temperature • Burdon tube pressure gauge is used to measure pressure • Thermocouple is used for temperature measurement of gas turbine exhaust, diesel engines, and other industrial processes. • **Non-Contact Transducer** • Stroboscope is used to measure speed of rotating member • Infrared thermometer is used to measure temperature of a body • Optical Pyrometer is used for high temperature measurement • Sound level meter is used to measure sound in dB. •	**2 Marks** **(Any Two)**
	(b)	**Draw and explain working of ultrasonic flow meter**  The working principle of ultrasonic flow meter is, it uses sound waves to resolve the velocity of a liquid within a pipe. There are two conditions in the pipe like no flow and flowing. In the first condition, the frequencies of ultrasonic waves are transmitted into a pipe & its indications from the fluid are similar. In the second condition, the reflected wave's frequency is dissimilar because of the Doppler Effect. Whenever the liquid flows in the pipe quickly, then the frequency shift can be increased linearly. The transmitter processes the signals from the wave & its reflections determine the flow rate. Transit time meters transmit & receive ultrasonic waves in both the directions within the pipe. At no-flow condition, the time taken to flow in between upstream & downstream in between the transducers is the same. Under these two flowing conditions, the wave at upstream will flow with less speed than the downstream wave. As the liquid flows faster, the distinction between the up & downstream times raises. The times of the upstream & downstream processed by the transmitter to decide the flow rate.	**2 Marks (Dig.)** **(4 Marks for Working)**

	(c)	**Draw the constructional details of 'sling psychrometer'. Write the procedure of measuring air properties using sling psychrometer and Psychometric chart** Construction details : •The equipment used to measure dry bulb and wet bulb temperature simultaneously is known as 'Psychrometer'. • The sling psychrometer consists of two mercury thermometers mounted on frame, which has handle provided for rotation of psychrometer.  • One bulb among the two is covered with the wet cotton to read wet bulb temperature. And the other shows the dry bulb temperature. • After getting both the temperature find relative humidity by using psychromrtic chart, the method of measurement is explain bellow. **Humidity Measurement By Dry And Wet Bulb Thermometer - Psychometric Chart** • The absolute and relative humidity is determined by a psychrometer, a device containing two thermometers. • The temperature sensing bulb of one measure the environmental temperature indicates the dry bulb temperature. • Around the bulb of other thermometer wet cloth is wound which evaporate water to produce cooling which indicates the web bulb temperature. • For this reason, the psychrometer is known as dry and wet bulb thermometer. • Relative humidity is related to the difference between the dry and wet bulb thermometer. • Also, the key to humidity measurement is the psychometric chart, which graphically describes the properties of moist air.	**(2 Marks for const.)** **(1 Marks Dig.)** **(2 Marks Expl.)**

		• The relationship between various humidity variables such as wet and dry bulb temperatures, dew point and percent relative humidity and grains of moisture per cubic meter of air etc. at specified atmospheric pressures are given in the form of chart known as the psychometric chart shown in Fig.  As shown in Fig. • The dry bulb temperature lines are vertical, and dry bulb temperature read at the bottom of the chart. • The wet bulb and dew point temperature lines run diagonally downward to right, and their values are read at the left where the lines intersect with the 100% relative humidity line. • The percent lines of relative humidity curve upwards to the right, with the percent values indicated on the lines themselves. • The absolute humidity in grains per pound of air is read on the vertical scale at the horizontal line that leads from intersection of a wet bulb or dew point temperature line with a thy bulb line.	**(1 marks dig.)**
6.		**Attempt any TWO**	**2 X 6 = 12**
	(a)	**Write any two applications of following** **Orifice meter:** • It is used to measure the flow rate of fluids in their single state (i.e. gaseous state or liquid state). • It can also be used to measure the flow rate of fluids in a mixed state (both gaseous and liquid states) such as, wet steam, or natural gas with water. • Also used where robust construction of device is required. **ii. Venturi meter:** • Used where the permanent pressure loss is main problem and where the maximum accuracy is desired in the measurement of high viscous fluids. • Used to handle slurries and dirty liquids. **iii. Pitot tube:** • It is a device used for measuring the velocity of flow at any point in a pipe or a channel.	**(2 Marks for each)**

		• Used to determine flow in very large pipes or ducts. • Used in aircrafts and missiles.	
	(b)	**Draw flow diagram of FFT analyzer. Enlist any four applications of FFT** **Flow diagram of FFT Analyzer:-**  **Application of FFT Analyzer:-** 1) To measure the transfer function of a mechanical system. 2) In forensics, laboratory for measuring the wavelength of light at which a material will absorb in the infrared rays. 3) For analysis of sound and vibrations. 4) Vibration analysis of various drives and machines. 5) It is measure all frequency components at the same time	**(2 Marks Dig.)** **(4x1 Mark for each application)**
	(c)	**Explain with neat sketch the construction of slipping clutch tachometer**  **Slipping Clutch Tachometer** • It is mechanical type tachometer. • It uses mechanical movements for measurement speed. • A rotating shaft whose speed is to be measured is connected to indicator shaft with the help of slipping clutch. • Friction material is used to avoid metal contact. • During the engagement of clutch, the shaft speed is transferred to indicator shaft	**3 Marks dig.)** **(Explanation 3 Marks)**

		and spring attached to it. • The torque on the spring is calibrated in terms of speed which is indicated by pointer moving over a calibrated scale.	

END

22443

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions : (1) All Questions are *compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE : **5 × 2 = 10**

(a) State the working principle of 'RVDT'.

(b) Name different Torque Measuring Instruments.

(c) State the law of 'Intermediate Temperature'.

(d) Enlist types of flow meters.

(e) Define term 'Natural Frequency'.

(f) Enlist types of speed measurement devices.

(g) List desirable characteristics for force measuring sensor.

2. Attempt any THREE : **3 × 4 = 12**

(a) Differentiate between 'Accuracy' and 'Precision'.

(b) Explain working principle of 'Slip Ring' with neat sketch.

(c) Compare 'Radiation' and 'Optical' Pyrometer.

(d) Explain the working of 'Hot Wire Anemometer.

3. Attempt any THREE : **3 × 4 = 12**

(a) Explain term 'Drift' and 'Sensetivity'.

(b) Draw block diagram of Generalised Measuring System.

(c) Explain 'Infra-Red Sensor' with neat sketch.

(d) Explain working principle of photo-electric pressure transducer with sketch.

4. Attempt any THREE : **3 × 4 = 12**

(a) Draw 'Creep Curve' for force transducer.

(b) Enlist any four applications of 'Optical Pyrometer'.

(c) Draw labelled diagram of 'Pressure Thermometer'.

(d) Explain the procedure of 'Strain Measurement' of cantilever beam.

(e) Write sound level norms as per API.

(i) 4-cylinder I.C. engine

(ii) Centrifugal pump

(iii) Lathe Machine

(iv) Industrial Exhaust fan

5. Attempt any TWO : **2 × 6 = 12**

(a) Write two applications of following :

(i) Contact Transducer

(ii) Active Transducer

(iii) Non-contact Transducer

(b) Draw and explain working of 'Ultrasonic Flow Meter'.

(c) Draw the constructional details of 'Sling Psychrometer'. Write the procedure of measuring air-properties using 'Sling Psychrometer' and 'Psychrometric Chart'.

6. Attempt any TWO : **2 × 6 = 12**

(a) Write any two applications of following :

(i) Orifice Meter

(ii) Venturi Tube

(iii) Pitot Tube

(b) Draw flow diagram of FFT analyser. Enlist any four applications of FFT.

(c) Explain with neat sketch the construction of 'Slipping Clutch Tachometer'.

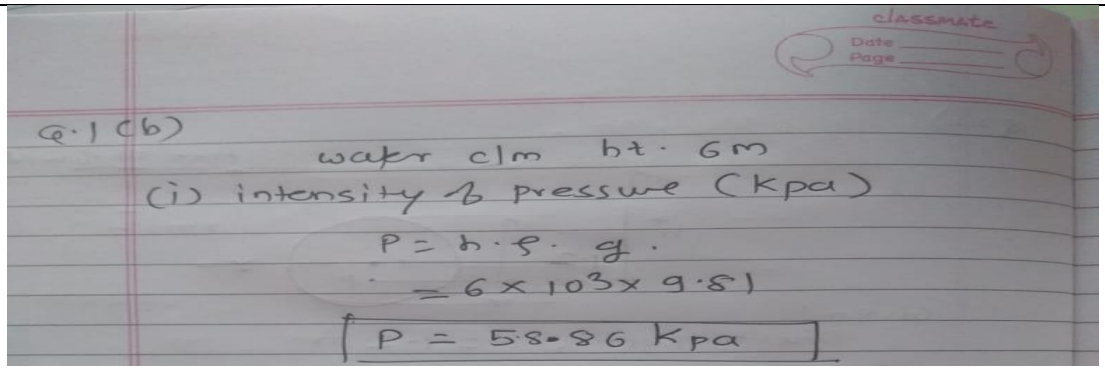
———————

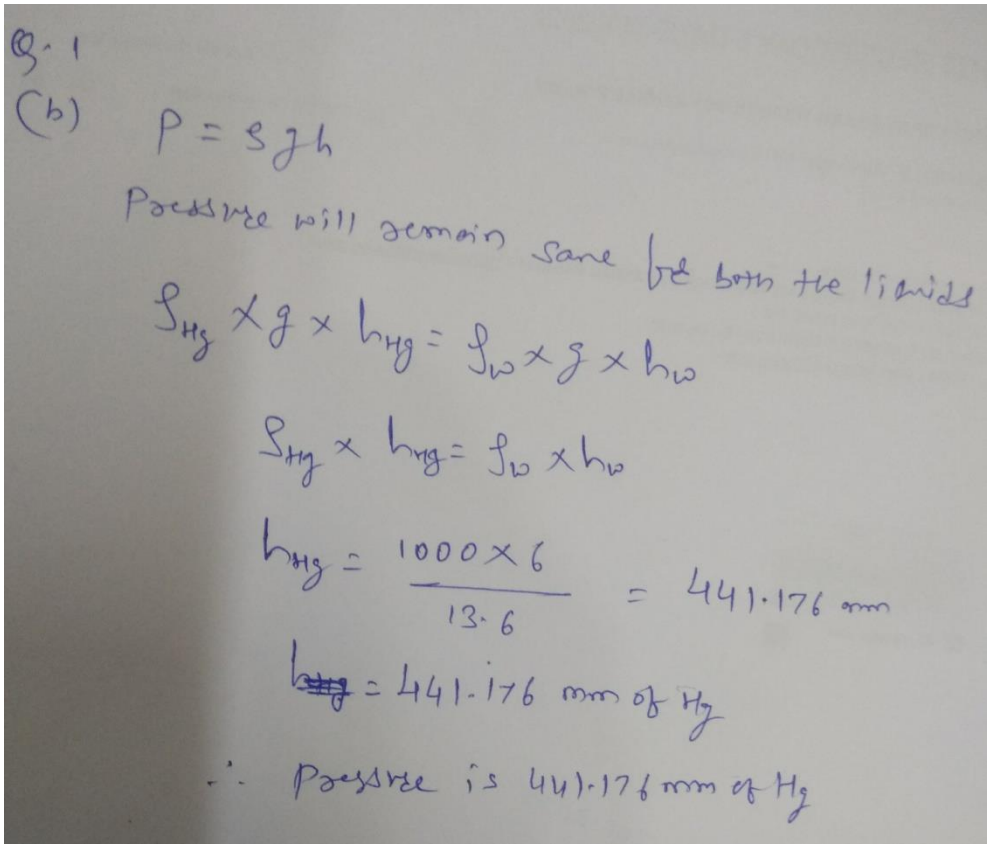
SUMMER – 2022 EXAMINATION

Subject Name: **Model AnswerSubject Code:** 22445

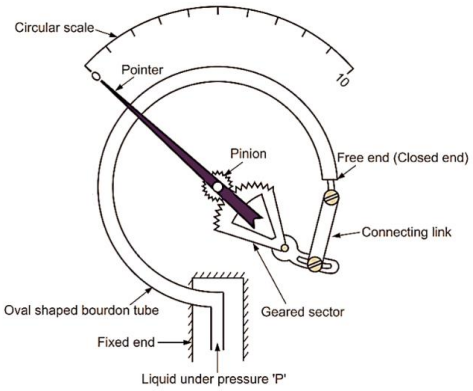
Important Instructions to examiners:

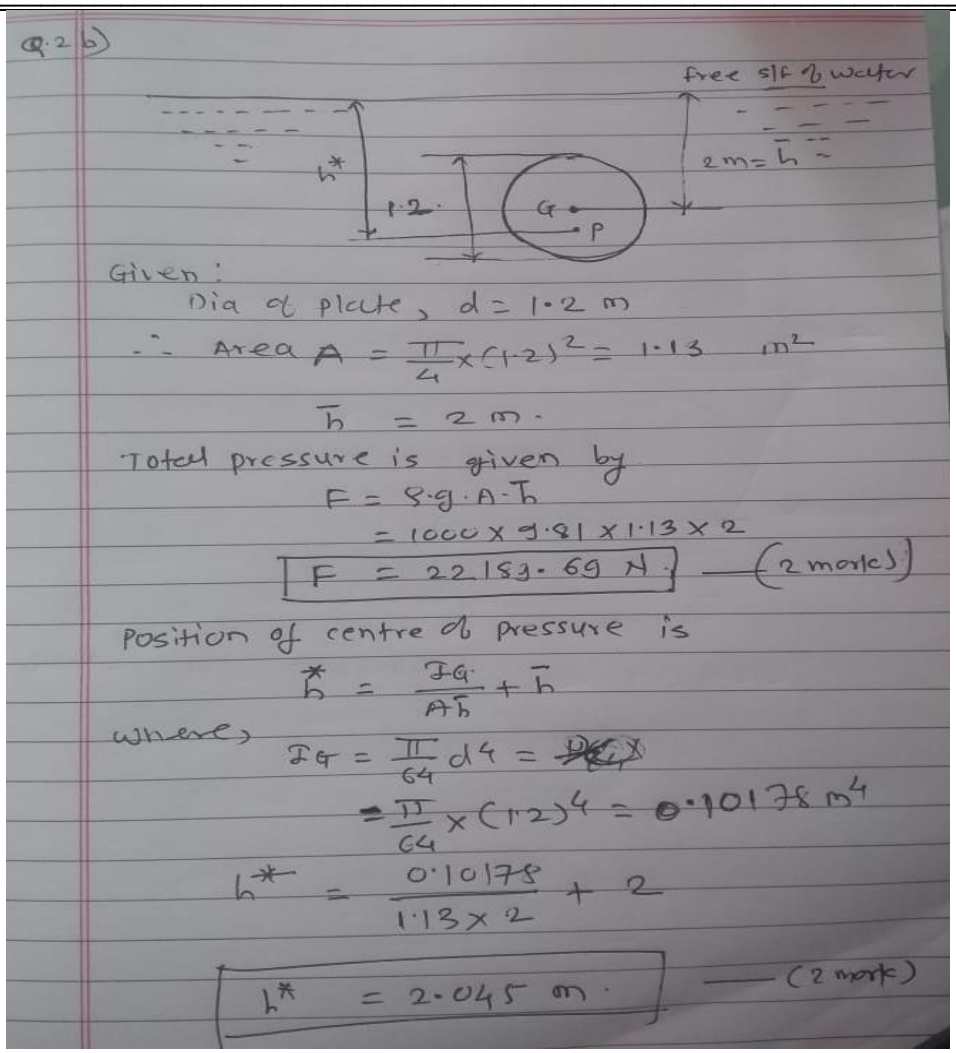
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

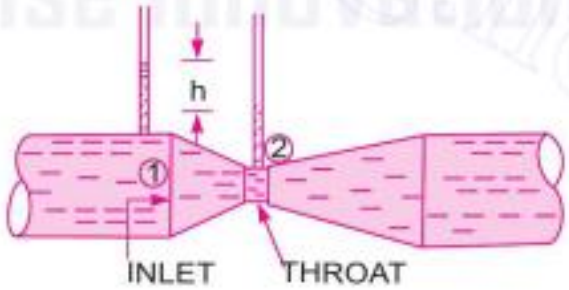
Q.1.		Attempt any FIVE of the following:	10 Marks
a)	i)	**Surface tension:** The property of the fluid which enables it to resist tensile stressis called surface tension.	01 M
	ii)	**Dynamic viscosity**: Dynamic viscosity μ, may be defined as the shear stress required to produce unit rate of angular deformation. Mathematically, $\mu = \frac{\tau}{dv/dy}$	01 M (either definition or methematical relation)
b)			1 M for P

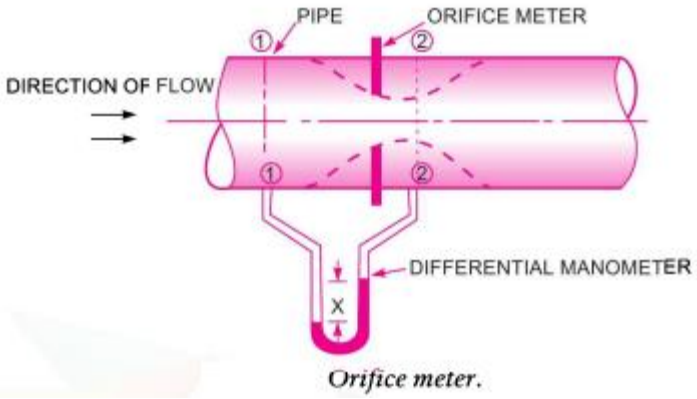
		10. 33 m ----- 760 mm og Hg 6 m = ? $\frac{6}{10.33} * 760 = \mathbf{441.41\ mm\ of\ Hg}$ **OR**  	1M for pressure in mm of hg
c)	i) ii)	**Steady Flow:**Fluid flow is said to be steady if at any point in the flowing fluid various characteristics such as velocity, pressure, density, temperature etc., do not change with time. **Unsteady or non-steady flow**: -Fluid flow is said to be unsteady if at any point in the flowing fluid any one or all the characteristics such as velocity, pressure, density, temperature etc., changes with time.	1M 1M
d)		**Laws of fluid friction for Turbulent Flow** Frictional resistance is proportional to square of velocity of flow.	2M

<table>
<tr><td></td><td></td><td>Frictional resistance is independent of pressure.
Frictional resistance slightly varies with change in temperature of fluid.
Frictional resistance is proportional to density of fluid flow.</td><td></td></tr>
<tr><td>e)</td><td></td><td>Minor Losses:-
Loss of head at Entry.
Loss of head at Exit.
Loss of head due to sudden enlargement.
Loss of head due to sudden contraction
Loss of head due to sudden obstruction.
Loss of head due to bend or Elbow.</td><td>Any four Losses 2M</td></tr>
<tr><td>f)</td><td></td><td><table><tr><td>Sr. No.</td><td>Specific Speed</td><td>Type of turbine</td></tr><tr><td>i)</td><td>8.5 to 30(10 to 35)</td><td>Pelton wheel with single jet</td></tr><tr><td>ii)</td><td>50 to 340(60 to 400)</td><td>Francis turbine</td></tr><tr><td>iii)</td><td>300 to 1000</td><td>Kaplan turbine or propeller turbine</td></tr></table></td><td>2M</td></tr>
<tr><td>g)</td><td></td><td>The main components of reciprocating pump are as follows:
Suction Pipe
Suction Valve
Delivery Pipe
Delivery Valve
Cylinder
Piston and Piston Rod
Crank and Connecting Rod
Strainer</td><td>Any four
2 M</td></tr>
</table>

2		**Attempt any THREE of the following:**	12 M
a)		**Bourdon tube pressure gauges** are used for the measurement of relative pressures from 0.6 ... 7,000 bar. They are classified as mechanical pressure measuring instruments, and thus operate without any electrical power. **Bourdon tube pressure gauge** Bourdon tubes are radially formed tubes with an oval cross-section. The pressure of the measuring medium acts on the inside of the tube and produces a motion in the non-clamped end of the tube. This motion is the measure of the pressure and is indicated via the movement. The C-shaped Bourdon tubes, formed into an angle of approx. 250°, can be used for pressures up to 60 bar. For higher pressures, Bourdon tubes with several superimposed windings of the same angular diameter (helical tubes) or with a spiral coil in the one plane (spiral tubes) are used.  	02 M 02 M For fig.

b)			01 m to find out area (A), 01 m for F, 01 m for IG, 01 m for h
			1M for

c)		 *Venturimeter.*	Fig.
		Construction : As stated above it has three parts converging part, throat and diverging part. These three parts are arranged in systematic order. First one is inlet section or converging section. It is the region where the cross section emerges into conical shape for the connectivity with the throat region. .In this part cross section area decreases from beginning to ending. This section is connected to inlet pipe on one end and cylindrical throat on the other end. The angle of convergence is generally 20-22 degrees . Second one is cylindrical throat .It is the middle part of the venturimeter. It is the cylindrical pipe in venturimeter through which the fluid passes after converging in the convergent section. Throat has generally a diameter of throat is half the diameter of pipe. The diameter of the throat remains same through out its length. Last one is diverging section . It is the end of the venturimeter. On one side it is attached to throat of venturimeter and on the other side it is attached to the pipe. The divergent section has an angle 5 to 15 degrees . The diverging angle is less than the converging angle because the length of the diverging cone is larger than converging cone. The main reason of the small diverging angle is to avoid flow seperation from the walls. **Working** :- Venturimeter works on the principle of Bernoulli's equation i.e when velocity increases pressure decreases . Cross section of throat is less than cross section of inlet pipe. Since the cross -section decreases from inlet pipe to throat, the velocity of the fluid increases and hence the pressure decreases. Due to decrease in pressure, a pressure difference is created between the inlet pipe and throat of the venturimeter . This pressure difference can be measured by placing a differential manometer between the inlet section and throat section or by using two guages at inlet section and throat. After getting the pressure difference flow rate through pipe is calculated.	1& 1/2 M for constructio n 1& 1/2 M working

d)		 *Orifice meter.*	1M for Fig
		d1 = Diameter at section 1 (Inlet section) P1 = Pressure at section 1 (Inlet section) v1 = Velocity of fluid at section 1 (Inlet section) A1 = Area of pipe at section 1 (Inlet section) d2 = Diameter at section 2 P2 = Pressure at section 2 v2 = Velocity of fluid at section 2 A2 = Area at section 2	3 M for Equation
		We will have following equation after applying Bernoulli's equation at section 1 and section 2.	
		$\frac{p_1}{\rho g}+\frac{v_1^2}{2g}+z_1=\frac{p_2}{\rho g}+\frac{v_2^2}{2g}+z_2$ $\Rightarrow\left(\frac{p_1}{\rho g}+z_1\right)-\left(\frac{p_2}{\rho g}+z_2\right)=\frac{v_2^2-v_1^2}{2g}$ $\Rightarrow h=\frac{v_2^2-v_1^2}{2g}$ $\Rightarrow v_2=\sqrt{2gh+v_1^2}$ where h is the differential head.	
		Let A0 is the area of the orifice Co-efficient of contraction, CC = A2/A0 Let us recall the continuity equation and we will have following equation	

$$A_1 v_1 = A_2 v_2$$

$$\Rightarrow v_1 = \frac{A_0 C_c}{A_1} v_2$$

$$v_2 = \sqrt{2gh + \frac{A_0^2 C_c^2 v_2^2}{A_1^2}}$$

$$\Rightarrow v_2 = \frac{\sqrt{2gh}}{\sqrt{1 - \frac{A_0^2}{A_1^2} C_c^2}}$$

Thus, discharge,

$$Q = A_2 v_2 = v_2 A_0 C_c = \frac{A_0 C_c \sqrt{2gh}}{\sqrt{1 - \frac{A_0^2}{A_1^2} C_c^2}}$$

If C_d is the co-efficient of discharge for orifice meter, which is defined as

$$C_d = C_c \frac{\sqrt{1 - \frac{A_0^2}{A_1^2}}}{\sqrt{1 - \frac{A_0^2}{A_1^2} C_c^2}}$$

$$\Rightarrow C_c = C_d \frac{\sqrt{1 - \frac{A_0^2}{A_1^2} C_c^2}}{\sqrt{1 - \frac{A_0^2}{A_1^2}}}$$

Thus we will use the value of CC in above equation of discharge Q and we will have following result for rate of flow or discharge through orifice meter.

$$Q = C_d \frac{A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

Co-efficient of discharge of the orifice meter will be quite small as compared to the co-efficient of discharge of the venturimeter.

3	a	**Attempt any THREE of the following:** **A venturi meter having throat diameter 6.3 cm is provided on a pipe of 15 cm diameter. If oil of specific gravity 0.88 is flowing in the upward direction, determine the Ventury head and the discharge if the manometer shows 12.80 cm of mercury deflection. If the vertical**	01 m to find h(ventury head), 02 m for

distance between inlet and throat is 22 cm. Determine the actual head of the venturi meter. Assume Cd = 0.65.

Throat dia, d2= 6.3cm , $a2 = \frac{\pi}{4} d2^2$= 31.17 cm2

Pipe dia , d1= 15 cm, $a1 = \frac{\pi}{4} d1^2$= 176.71 cm2

Sp Gravity of oil Soil= 0.88

Manometer Reading , x= 12.8 cm of Hg

Cd =0.65

1.Ventury Head (h)

$h = x\left(\frac{Shg}{Soil} - 1\right) = 12.8\left(\frac{13.6}{0.88} - 1\right) = 185.01 cm\ of\ oil$----------01 mark

2.Discharge (Q) ----------02 mark

$$Q = Cd * a1 * a2 * \frac{\sqrt{2gh}}{\sqrt{a1^2 - a2^2}}$$

$$= 0.65 * 176.71 * 31.17 * \frac{\sqrt{2 * 981 * 18501}}{\sqrt{176.71^2 - 31.17^2}}$$

Q= 12400.99 cm3/sec

Q= 12.4 litres / sec

3.Actual Ventury Head if Z2-Z1= 22cm ----------01 mark

$$\left(\frac{p1}{\rho g} + Z1\right) - \left(\frac{p2}{\rho g} + Z2\right) = h$$

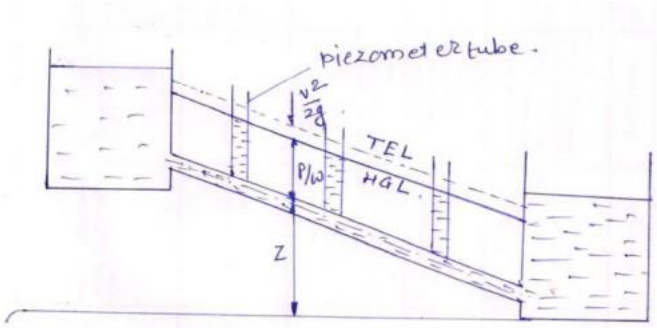
$$\left(\frac{p1}{\rho g} - \frac{p2}{\rho g}\right) + Z1 - Z2 = h$$

Z2-Z1= 22 cm , h = 185.01

Therefore ,

$$\left(\frac{p1}{\rho g} - \frac{p2}{\rho g}\right) = 185.01 + 22 = 207.01\ cm\ of\ oil$$

discharge, 01 for actual head

	b	**Explain the terms hydraulic gradient and total energy lines with diagram.** Hydraulic Gradient Line It is defined as the line which gives the sum of pressure head (p/w) and datum head (z) of a flowing fluid in a pipe with respect to some reference line. OR It is the line which is obtained by joining the top of all vertical ordinates, showing the pressure head of a flowing fluid in a pipe from center of the pipe. Total Energy Line (TEL) (Explain with diagram 2m) It is defined as the line which gives the sum of pressure head, datum head and kinetic head of a flowing fluid in a pipe with respect to some reference line. OR It is defined as the line which is obtained by joining the tops of all the tops of all vertical ordinates showing the sum of pressure head and kinetic head from center of the pipe.  $HGL = Z + P/w$ $TE = Z + P/w + \frac{v^2}{2g}$	02 marks sketch, 02 marks explanation
	c	**Find the diameter of a pipe of length 9 km, when rate of flow of water through the pipe is 255 litre/sec. and head loss due to friction is 6.5 m. Take C = 55 for Chezy's formula.** Given Data: L=9 km = 9000 m, Q= 255 lit /sec = 0.255 m3/sec, hf= 6.5 m---------(1 mark) $Q = A * V \quad , V = \frac{Q}{A} \quad = \frac{0.255}{\left(\frac{\pi}{4}\right)*d^2}$ ----------(1 mark) Chezy's formula , V= $C\sqrt{mi}$ = 55 $\sqrt{\frac{d}{4} * \frac{hf}{L}}$= 55 $\sqrt{\frac{d}{4} * \frac{6.5}{9000}}$----------(2 mark)	01 m for unit conversion , 01 m for Q, 01 for chezy'sformula ,01 mark for finding d.

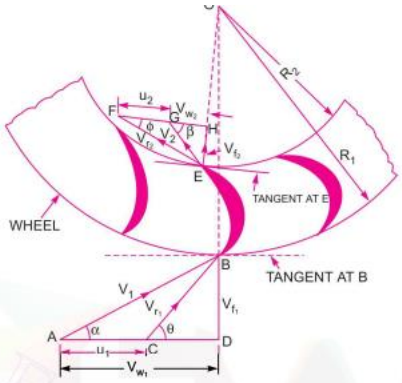
$$\frac{0.255}{\left(\frac{\pi}{4}\right)*d^2} = 55\sqrt{\frac{d}{4}*\frac{6.5}{9000}}$$

Solving above equation

d = 0.7196 m

Diameter of a pipe is d= 719.6 mm

d Find equation for force and work done for the impact of jet on a series of moving radial vanes (As applied to turbines). — 04 marks



Let R_1 = Radius of wheel at inlet of the vane,
R_2 = Radius of the wheel at the outlet of the vane,
ω = Angular speed of the wheel.

Then $u_1 = \omega R_1$ and $u_2 = \omega R_2$

The velocity triangles at inlet and outlet are drawn as shown in Fig. 17.23.

The mass of water striking per second for a series of vanes
= Mass of water coming out from nozzle per second
= $\rho a V_1$, where a = Area of jet and V_1 = Velocity of jet.

Momentum of water striking the vanes in the tangential direction per sec at inlet
= Mass of water per second × Component of V_1 in the tangential direction
= $\rho a V_1 \times V_{w_1}$ ($\because$ Component of V_1 in tangential direction = $V_1 \cos\alpha = V_{w_1}$)

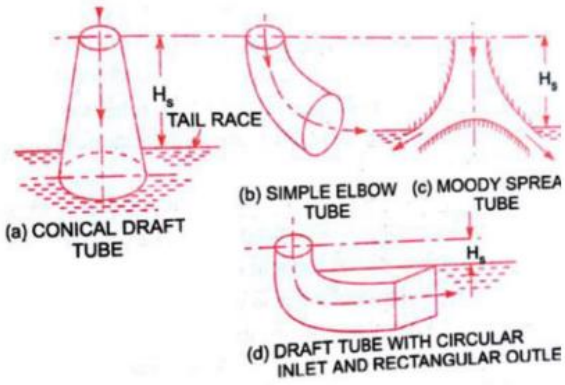
Similarly, momentum of water at outlet per sec
= $\rho a V_1 \times$ Component of V_2 in the tangential direction
= $\rho a V_1 \times (-V_2 \cos\beta) = -\rho a V_1 \times V_{w_2}$ ($\because$ $V_2 \cos\beta = V_{w_2}$)

–ve sign is taken as the velocity V_2 at outlet is in opposite direction.

Now, angular momentum per second at inlet
= Momentum at inlet × Radius at inlet
= $\rho a V_1 \times V_{w_1} \times R_1$

Angular momentum per second at outlet
= Momentum of outlet × Radius at outlet
= $-\rho a V_1 \times V_{w_2} \times R_2$

		Torque exerted by the water on the wheel, T = Rate of change of angular momentum = [Initial angular momentum per second – Final angular momentum per second] $= \rho a V_1 \times V_{w_1} \times R_1 - (-\rho a V_1 \times V_{w_2} \times R_2) = \rho a V_1 [V_{w_1} \times R_1 + V_{w_2} R_2]$ Work done per second on the wheel = Torque × Angular velocity = $T \times \omega$ $= \rho a V_1 [V_{w_1} \times R_1 + V_{w_2} R_2] \times \omega = \rho a V_1 [V_{w_1} \times R_1 \times \omega + V_{w_2} R_2 \times \omega]$ $= \rho a V_1 [V_{w_1} u_1 + V_{w_2} \times u_2]$ $(\because \quad u_1 = \omega R_1$ and $u_2 = \omega R_2)$ F_x is written as $F_x = \rho a V_{r_1} [V_{w_1} \pm V_{w_2}]$	
	e	A jet of water 10 cm diameter strikes on a flat plate with a velocity of 20 m/s. The plate is moving with a velocity of 10m/s in the direction of jet and away from the jet. Find the efficiency of the jet. Given data : Dia. Of pipe , d = 10 cm Velocity of the Jet ,V= 20 m/s Velocity of the plate ,u = 10 m/s $Densityofthewater$, $\text{þ} = 1000\ kg\ /m3$ $F = \text{þ} * a * (V - u)2$ $F = 1000 * \frac{\pi}{4} d^2 * (V - u)2$----------(1 mark) $KEatinlet = (\frac{1}{2} * \text{þ} * a * V3)$----------(1 mark) Efficiency of the jet. $\varkappa = \frac{\text{work done per}}{Energyatinlet} = \frac{F*u}{KE} = \frac{\text{þ}*a*(V-u)2*u}{(\frac{1}{2}*\text{þ}*a*V3)} = \frac{2*(20-10)^2*10}{20^3}$ =0.25-------(2 mark) Efficiency of the jet. $\varkappa$ =25 %	01 m to find out F, 01 m for KE, 02 m for efficiency.
4	a	Attempt any THREE of the following: Describe with neat sketches different types of draft tubes with use.	2 marks for fig. and 2 marks for explanation



Conical Draft Tube: (Straight Divergent Tube) The shape of this tube is that of frustum of a cone. It is usually employed for low specific speed, vertical shaft Francis turbine. The cone angle is restricted to 8 to avoid the losses due to separation. The tube must discharge sufficiently low under tail water level. The maximum efficiency of this type of draft tube is 90%.

Simple Elbow Type The draft tube is bent to keep its definite length. Simple elbow type draft tube will serve such a purpose. Its efficiency is, however, low (about 60%). This type of draft tube turns the water from the vertical to the horizontal direction with a minimum depth of excavation. The horizontal portion of the draft tube is generally inclined upwards to lead the water gradually to the level of the tail race and to prevent entry of air from the exit end.

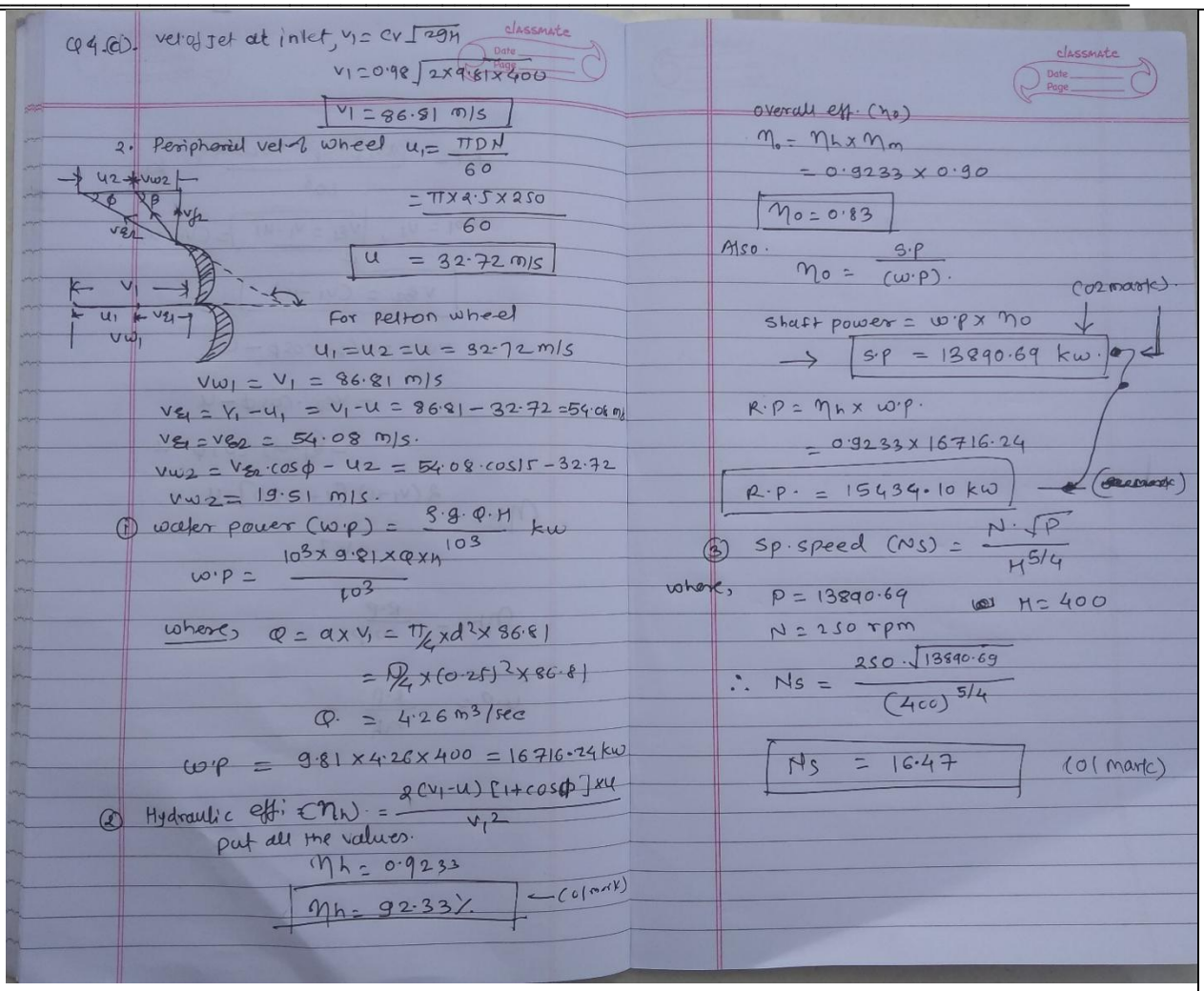
Elbow Draft Tube It is circular in cross section at inlet in its vertical leg which turns into rectangular cross section in horizontal portion of tube at outlet. The horizontal portion of tube is gradually inclined upwards so that water leaves tube almost at tail race level. Efficiency of this tube is in range of 60 to 80%

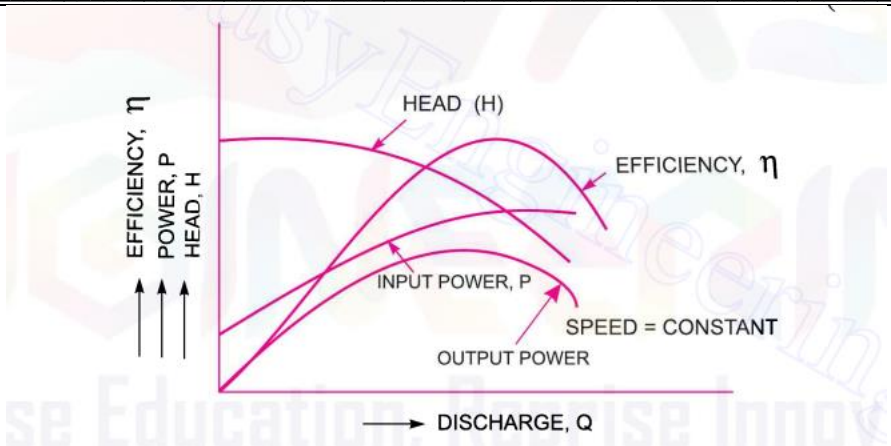
Moody's Spreading Draft Tube: This is a modification of conical tube and a solid conical cone is provided in the center of the tube with a flare at the bottom end. Such an arrangement allows a large exit area without excessive length. The solid core at the center enables full flow and reduces the eddy losses. The efficiency of the tube is about 85%.

	b		04 marks 01 m for each point

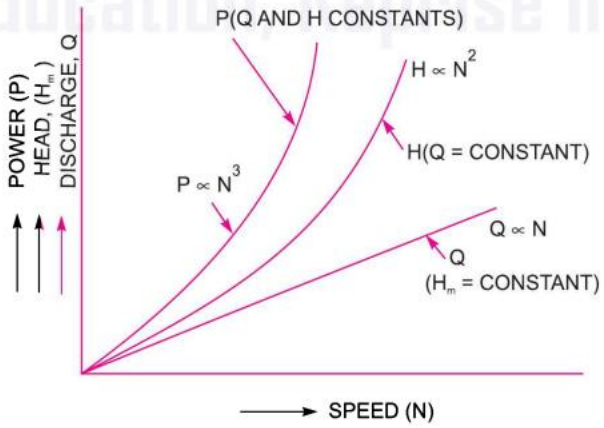
Sr no	Parameter	Francis Turbine	Kaplan Turbine
1	Construction-Entry of Water	It is radial flow turbine	It is axial Flow turbine
2	Number of vanes	It has large number of vanes i.e. 16 to 24	It has small number of vanes i.e.3 to 8
3	Position of vanes	The runner vanes are fixed	The runner vanes are adjustable which are fixed on hub
4	Working	It is used for medium head and medium discharge	It is used for low head and high discharge
5	Frictional resistance	Frictional resistance is high due to number of large no of vanes	Reduced frictional resistance due to small number of large no of vanes

	c	A pelton wheel 2.5m diameter operates under the following conditions. i) Net available head (H) = 400m ii) Speed (N) = 250rpm iii) Coefficient of velocity of the jet (Cv) = 0.98 iv) Friction coefficient for vanes (K) = 0.95 v) Blade Angle (6) = 15° vi) Diameter of jet (d) = 25 cm vii) Mechanical efficiency (nm) = 0.90 Determine: 1) The power developed 2) Hydraulic efficiency 3) Specific speed	01 m to find out u, 01 m for water power, 01 m for hydraulic efficiency, 01 m for sp. speed

			
	d	Draw and explain the main characteristics curves of centrifugal pump in discharge Vs overall efficiency.	figure for 2 marks and explainatio n for 2 marks



Main characteristics curves The main characteristics curves are obtained by keeping the pump at constant speed and varying the discharge over desired range. The discharge is varied by means of deliver valve. For different values of discharge the measurements are taken or calculated for manometric head, shaft power and efficiency These curve are useful in evaluating the performance of pump at different speeds.



	e	Write **any four** operational difficulties commonly experienced in centrifugal pump and their remedies. 1. Pump Running Dry If you are not getting any flow after starting your centrifugal pump, there could be several different causes and remedies. Air in pump — Ensure the pipework and pump are completely filled with liquid. Suction lift is too high — Check for any obstructions in the inlet and verify that static lift is correct. Clogged parts — Check and clean the valve, impeller, and strainer.	04 m 1 m for each

2. Reversed Impeller Rotation

Impellers rotating in the wrong direction is a common problem with centrifugal pumps. If the impellers turn the wrong way, they could cause severe damage to the pump. When wiring power to the pump's motor, it's critical to verify which way the motor turns. You can "bump start" the motor to do this.

3. Pump Leakage

Another common problem with these types of centrifugal pumps is leakage. When materials escape the pump and create a mess, this is a serious issue. Excessive temperature, corrosion, or pressure can loosen the joints and seals, allowing fluid and debris to escape.

But there may be a simple fix. Stopping your leaky pump could be as easy as tightening the fasteners surrounding the joints. In other cases, however, may need to replace a gasket or mechanical seal.

4. Slow Pump Re-Priming

There is probably something wrong with pump if it takes too long to re-prime. The most common cause of a slow re-priming pump is excessive clearance, leading to inefficiency and overheating. But other possible reasons exist as well, such as a leaking gasket, a clogged recirculation port, or a worn-out volute.

5. Pump Seizure

Pump seizure can happen for several reasons, including foreign objects entering the pump, low flow operation, and off-design conditions. Inspect the pump for foreign objects and debris first and then check the impellers and power source.

6. Pump Vibration

When the pump vibrating too much or notice usual noises coming from the device, this could signify a serious issue. Often, vibrations and noises tell that failed bearings or a foreign object stuck inside the pump.

Start with the most straightforward thing first and look for debris or foreign objects. When noises and vibrations occur together, the pump could be experiencing cavitation and may need to be examined by a professional.

7. Debris in Pump

Debris in your pump can create havoc with many of its parts and systems. If pump isn't pumping or is less efficient , check for a clogged suction pipe or debris in the impeller.

8. Pump Driver Overloaded

In centrifugal pumps, overloading occurs when the driving motor draws excess current, which

results in greater than normal power consumption. Pumps should start with a minimum load with discharge valves open. If the power drawn by the pump increases too much, it may ultimately lead to tripping or overloading of the motor. Some of the most common causes of pump driver overload include:

- The speed of the pump is too fast
- An oversized impeller was installed
- Worn or damaged bearings
- Processing liquids of higher viscosity
- Bent shaft
- Misalignment between driver and pump
- Mechanical seal putting too much pressure on the seat
- Stationary parts coming into contact with rotating parts
- Pump operating too far out of optimum range

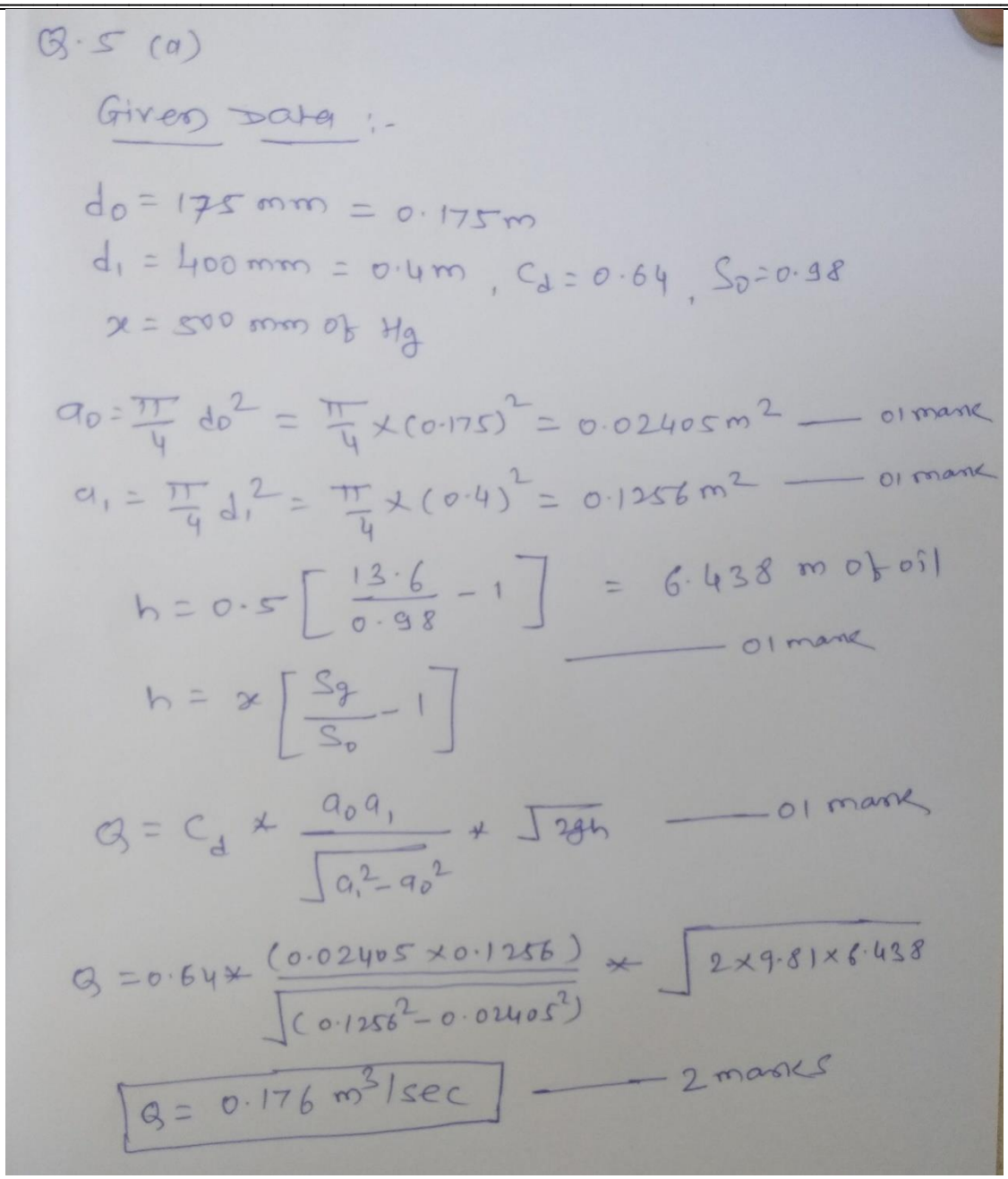
9. Poor Efficiency

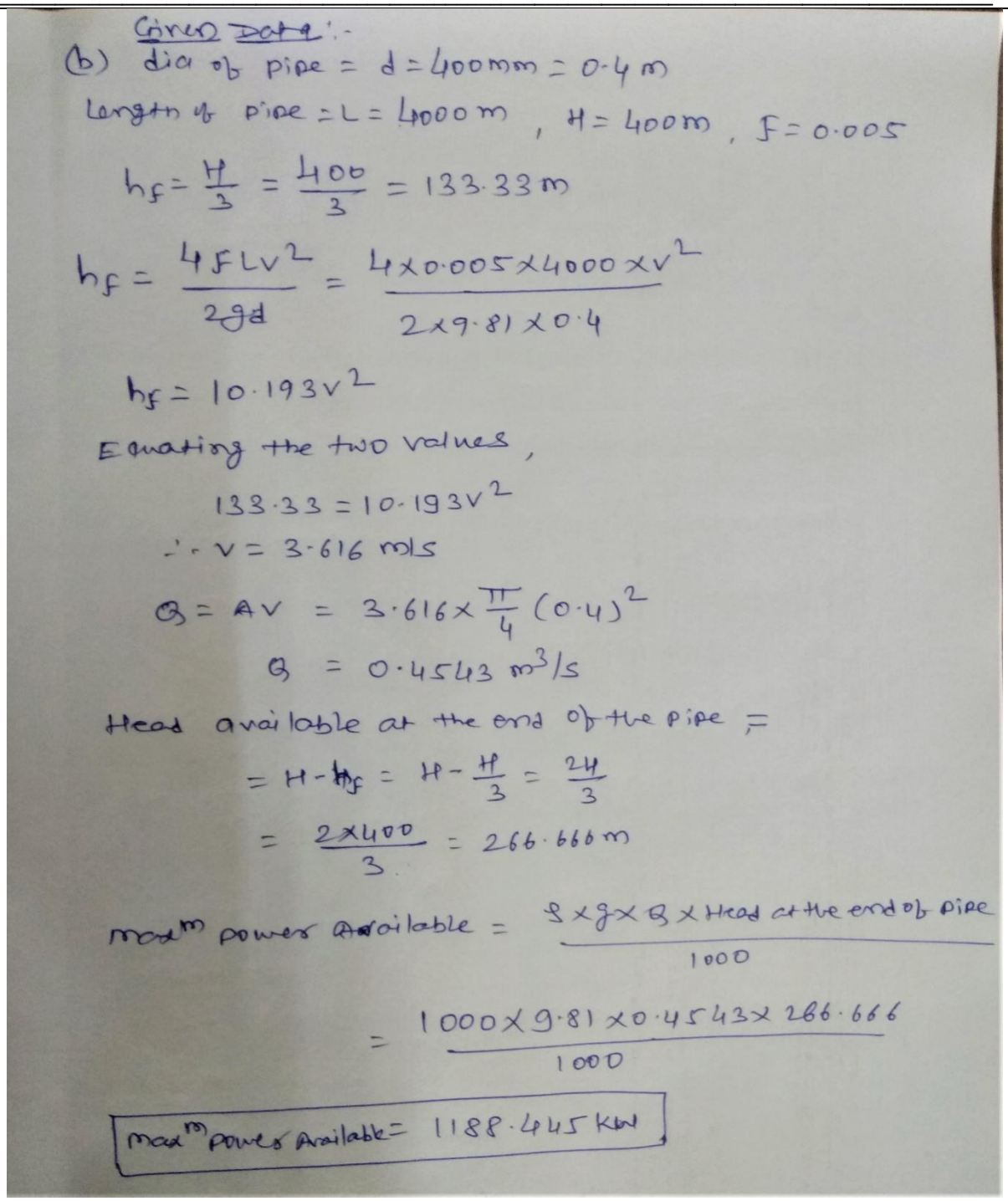
If the pump isn't operating efficiently anymore, meaning it's taking too long for it to pump out fluid, some of the most common causes of this problem include the following.

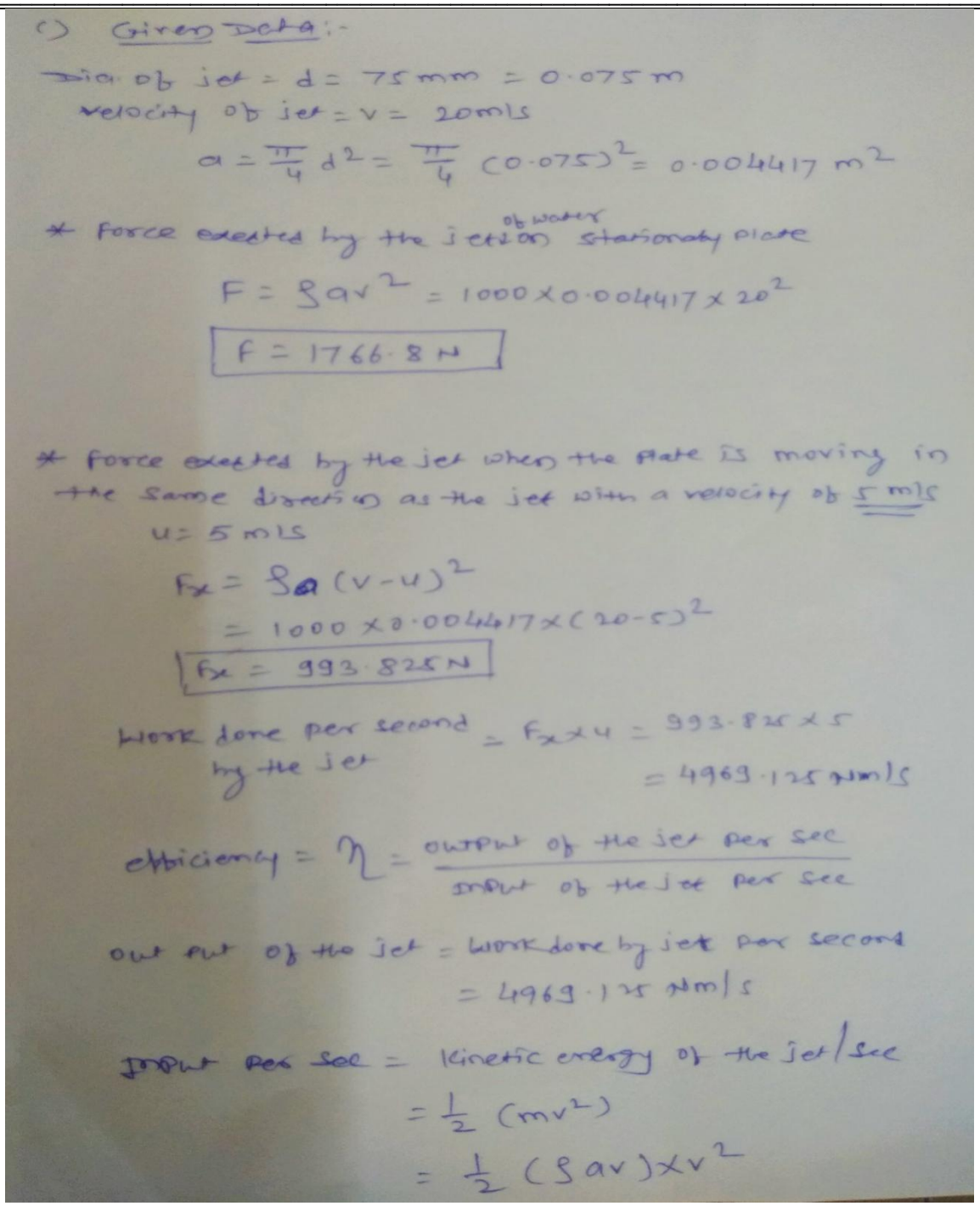
- A leaky gasket
- Incorrect impeller rotation
- Damaged or worn impeller, worn-out ring, or damaged wear plate
- An open bypass valve
- Blockage in pump inlet, discharge line, or impeller

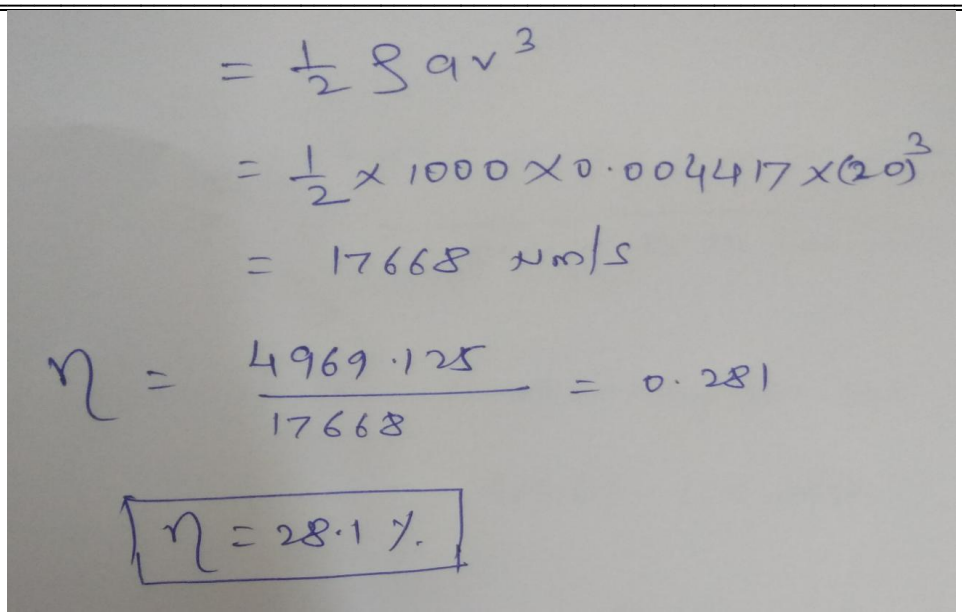
10. Bearing Overheating

Centrifugal pumps should not feel hot to the touch. When they do, this is a sign of trouble . There may be a blockage in the suction strainer, the recirculation port, the valve, or the open-ended discharge line.

5	a		To find ao---1m a1---1m h---1m Q formula 1m Q----2 m

	b		Hf---2m Q---1m Head ---1m Power – 2m

	c		F---1m Fx--- 1m Work done--- 1m Efficiency --- 3m



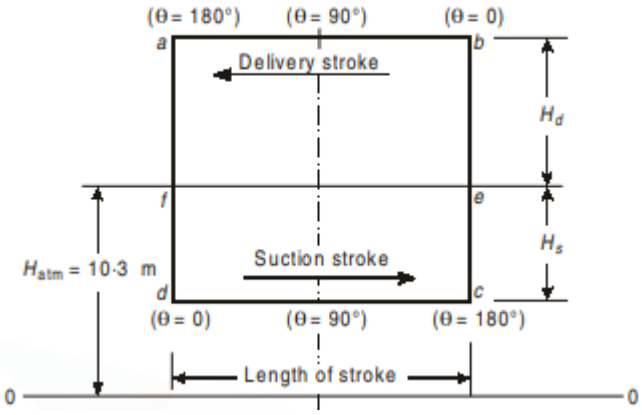
6 a

Impulse Turbine	Reaction Turbine
1. The entire available energy of the water is converted into kinetic energy.	1. Only a portion of the fluid energy is converted into kinetic energy before the fluid enters the turbine runner.
2. The work is done only by the change in the kinetic energy of the jet	2. The work is done partly by the change in the velocity head, but almost entirely by the change in pressure head.
3. Flow regulation is possible without loss.	3. It is not possible to regulate the flow without loss.
4.. Unit is installed above the tailrace.	4. Unit is entirely submerged in water below the tailrace.
5. Casing has no hydraulic function to perform, because the jet is unconfined and is at atmospheric pressure. Thus, casing serves only to prevent splashing of water.	5. Casing is absolutely necessary, because the pressure at inlet to the turbine is much higher than the pressure at outlet. Unit has to be sealed from atmospheric pressure.
6. It is not essential that the wheel should run full and air has free access to the buckets	6. Water completely fills the vane passage.
7. Pelton wheel Turbine	7.Frances Turbine, Kaplan Turbine
8.No need of draft tube	8. Draft tube required
9.High head	9. Low or medium head

b **Indicator Diagram: -** The indicator diagram for a reciprocating pump is defined as the graph between the pressure head in cylinder and the distance travelled by the piston from inner dead centre for one complete revolution of the crank.

02 m for theoretical indicator dig. 2m for

Theoretical Indicator Diagram for Single acting reciprocating pump:-



Effect of Acceleration and Friction in Suction and Delivery Pipes on Indicator Diagram.

Fig. shows the combined effect of acceleration and friction in suction and delivery pipes. The pressure head in the cylinder during suction and delivery strokes will change as given below :

(*i*) At the beginning of the suction stroke, θ = 0° and hence h_{as} is equal to $\frac{l_s}{g} \times \frac{A}{a_s} \omega^2 r$. But $h_{fs} = 0$. Thus, the pressure head in the cylinder will be $(h_s + h_{as})$ below the atmospheric pressure head.

(*ii*) At the middle of the suction stroke, $h_{as} = 0$ but $h_{fs} = \frac{4 \times f \times l_s}{d_s \times 2g} \times \left(\frac{A}{a_s} \omega r\right)^2$. Thus, the pressure head in the cylinder will be $(h_s + h_{fs})$ below the atmospheric pressure head.

(*iii*) At the end of the suction stroke, $h_{as} = -\frac{l_s}{g} \times \frac{A}{a_s} \omega^2 r$ but $h_{fs} = 0$. Thus, the pressure head in the cylinder will be $(h_s - h_{as})$ below the atmospheric pressure head.

(*iv*) At the beginning of the delivery stroke, $h_{ad} = -\frac{l_d}{g} \times \frac{A}{a_d} \times \omega^2 r$ but $h_{fd} = 0$. Thus, the pressure head in the cylinder will be $(h_d + h_{ad})$ above the atmospheric pressure head.

explanation of effect,2m for fig of effect

(*v*) In the middle of the delivery stroke, $h_{ad} = 0$ and $h_{fd} = \frac{4 f l_d}{d_d \times 2g} \times \left(\frac{A}{a_d}\omega r\right)^2$. Thus the pressure head in the cylinder will be $(h_d + h_{fd})$ above the atmospheric pressure head.

(*vi*) At the end of the delivery stroke, $h_{ad} = -\frac{l_d}{g} \times \frac{A}{a_d} \times \omega^2 r$ and $h_{fd} = 0$. Thus, the pressure head in the cylinder will be $(h_d - h_{ad})$ above the atmospheric pressure head.

Thus, the indicator diagram with acceleration and friction in suction and delivery pipes will become as shown in Fig.

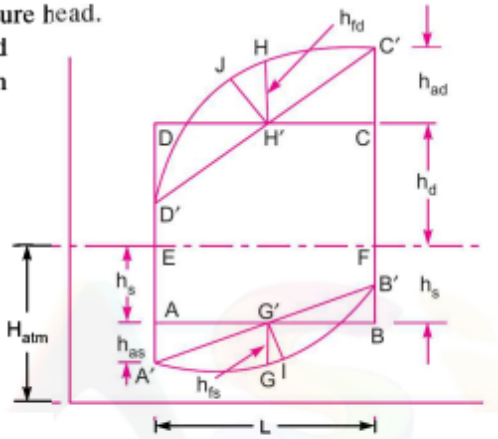
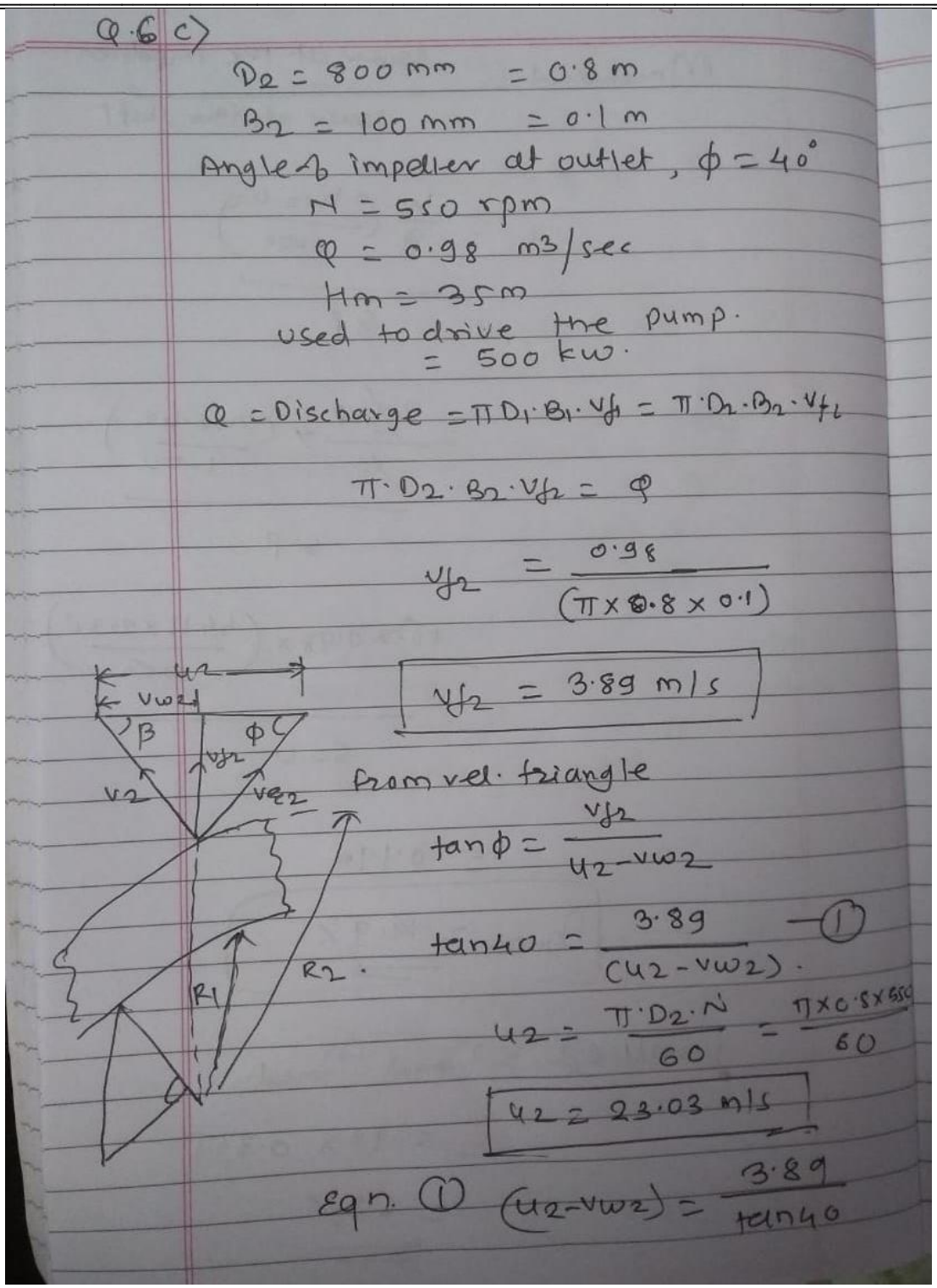


Fig. *Effect of acceleration and friction on indicator diagram.*

	c		01 m to find out Vf2, 01m u2, 01 m Vw2, 01 m manometric efficiency, 1 m mechnaical efficiency, 1 m overall efficiency

$23.03 - V_{w2} = 4.635$

$\boxed{V_{w2} = 18.39 \text{ m/s}}$

① Manometric eff. (η_m)

$$\eta_m = \frac{g \cdot H_m}{V_{w2} \cdot u_2}$$

$$= \frac{9.81 \times 35}{18.39 \times 23.03}$$

$\eta_m = 0.81$

$\boxed{\eta_{mano} = 81\%}$

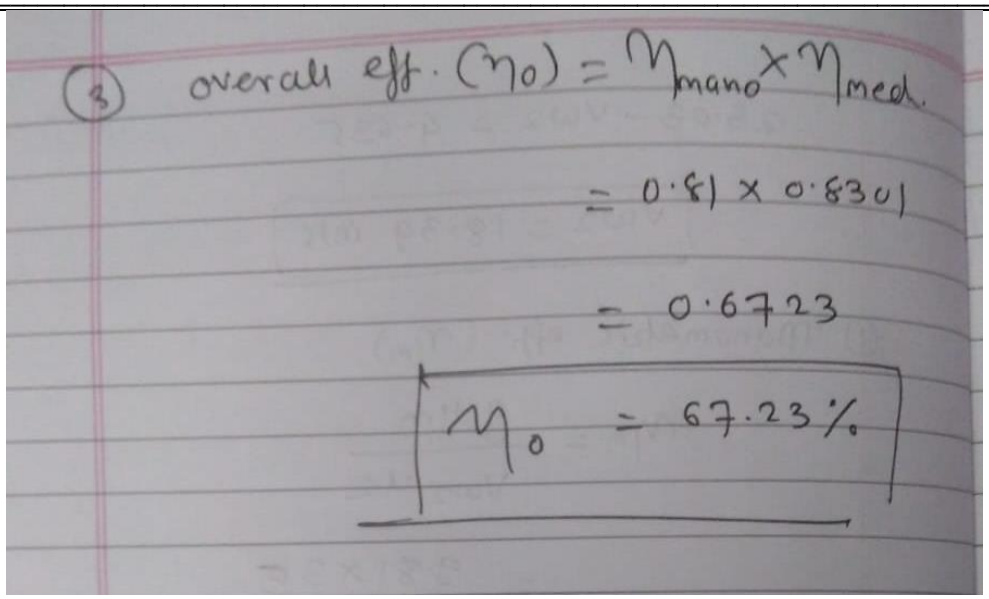
② $\eta_{mechanical} = \dfrac{\text{Impeller power}}{\text{shaft power}}$

$$= \frac{\frac{\rho g}{g}\left(\frac{V_{w2} \cdot u_2}{1000}\right)}{500}$$

$$= \frac{\frac{\rho \cdot g \cdot Q \cdot (V_{w2} \cdot u_2)}{g \times 1000}}{500}$$

$$= \frac{0.98\,(18.39 \times 23.03)}{500}$$

$\boxed{\eta_{mech.} = 0.830 \text{ or } 83.01\%}$


(3) overall eff. (η_o) = $\eta_{mano} \times \eta_{mech.}$
= 0.81 × 0.8301
= 0.6723
η_o = 67.23%

22445

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define

i) Surface tension

ii) Dynamic viscosity of fluid

b) For a water column of height 6 m,
Calculate -

i) Intensity of pressure (Kpa)

ii) Pressure in mm of Hg.

c) Define and distinguish between

i) Steady and unsteady flow

ii) Uniform and non-uniform flow

d) State the laws of fluid friction for turbulent flow.

e) State minor losses of energy of fluid flowing in pipe.

P.T.O.

Marks

f) Suggest the type of turbine to be used for following specific speed:

i) 8.5 to 30 (10 to 35)

ii) 50 to 340 (60 to 400)

iii) 300 to 1000

g) List the four basic components of reciprocating pump.

2. Attempt any THREE of the following: **12**

a) Explain construction and working of Bourdon pressure gauge with a neat sketch.

b) A circular plate 1.2 m diameter is placed vertically in water so that centre of the plate is 2 m below the free surface. Determine the depth of centre of pressure and total pressure on the plate.

c) Describe with sketch, construction and working principle of venturimeter.

d) Describe the equation for actual discharge through Orifice meter by applying Bernoulli's equation.

3. Attempt any THREE of the following: **12**

a) A venturimeter having throat diameter 6.3 cm is provided on a pipe of 15 cm diameter. If oil of specific gravity 0.88 is flowing in the upward direction, determine the Ventury head and the discharge if the manometer shows 12.80 cm of mercury deflection. If the vertical distance between inlet and throat is 22 cm. Determine the actual head of the venturimeter. Assume $C_d = 0.65$.

b) Explain the terms hydraulic gradient and total energy lines with diagram.

Marks

c) Find the diameter of a pipe of length 9 km, when rate of flow of water through the pipe is 255 litre/sec. and head loss due to friction is 6.5 m. Take C = 55 for Chezy's formula.

d) Find equation for force and work done for the impact of jet on a series of moving radial vanes (As applied to turbines).

e) A jet of water 10 cm diameter strikes on a flat plate with a velocity of 20 m/s. The plate is moving with a velocity of 10 m/s in the direction of jet and away from the jet. Find the efficiency of the jet.

4. Attempt any <u>THREE</u> of the following: **12**

a) Describe with neat sketches different types of draft tubes with use.

b) Compare Francis turbine with Kaplan turbine.

c) A pelton wheel 2.5 m diameter operates under the following conditions.

i) Net available head (H) = 400 m

ii) Speed (N) = 250 rpm

iii) Coefficient of velocity of the jet (Cv) = 0.98

iv) Friction coefficient for vanes (K) = 0.95

v) Blade Angle (ϕ) = 15°

vi) Diameter of jet (d) = 25 cm

vii) Mechanical efficiency (ηm) = 0.90

Determine :

1) The power developed

2) Hydraulic efficiency

3) Specific speed

Marks

d) Draw and explain the main characteristics curves of centrifugal pump in discharge Vs overall efficiency.

e) Write any four operational difficulties commonly experienced in centrifugal pump and their remedies.

5. Attempt any <u>TWO</u> of the following: **12**

a) An orifice meter with 175 mm diameter is inserted in a pipe of 400 mm. The pressure difference measured by a mercury oil differential manometer gives reading of 500 mm of Hg (mercury). Find the rate of flow of oil of specific gravity 0.98 and coefficient of discharge = 0.64.

b) A pipe of diameter 400 mm and length 4000 m is used for the transmission of power by water. The total head at the inlet of the pipe is 400 m. Find the maximum power available at the outlet of the pipe. If the value of f = 0.005.

c) A jet of water 75 mm diameter having a velocity of 20 m/s, strikes normally a flat smooth plate. Determine the thrust on the plate:

i) If the plate is at rest.

ii) If the plate is moving in the same direction as the jet with a velocity of 5 m/s.

Also find the work done per second on the plate in each case and the efficiency of the jet when the plate is moving.

Marks

6. Attempt any TWO of the following: **12**

a) Compare between impulse turbine and reaction turbine. (At least six points).

b) Describe an indicator diagram of a reciprocating pump. Sketch the theoretical indicator diagram for a single-acting reciprocating pump not fitted with an air vessel. Also explain clearly the effect of acceleration and friction on both suction and delivery strokes.

c) A centrifugal pump has the following characteristics:
Outer diameter of impeller = 800 mm;
Width of impeller vanes at outlet = 100 mm;
Angle of impeller vanes at outlet = 40°;

The impeller runs at 550 r.p.m. and delivers 0.98 m^3 of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine :-

i) Monometric efficiency

ii) Overall efficiency of the pump, and

iii) Mechanical efficiency

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SUMMER – 2022 EXAMINATION

Subject Name: Manufacturing Processes **Model AnswerSubject Code:** 22446

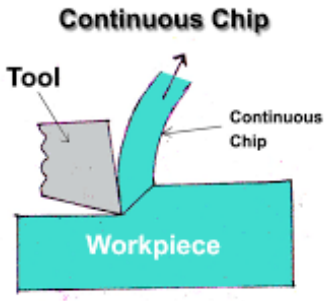
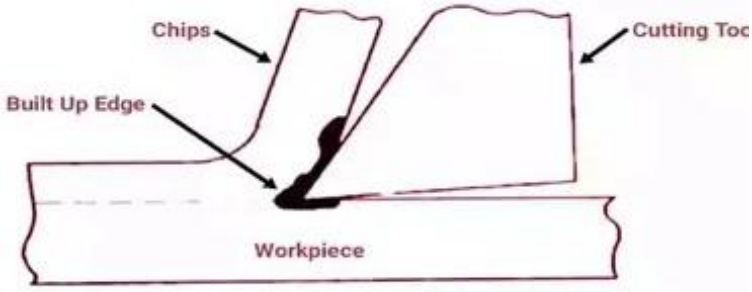
Important Instructions to examiners:

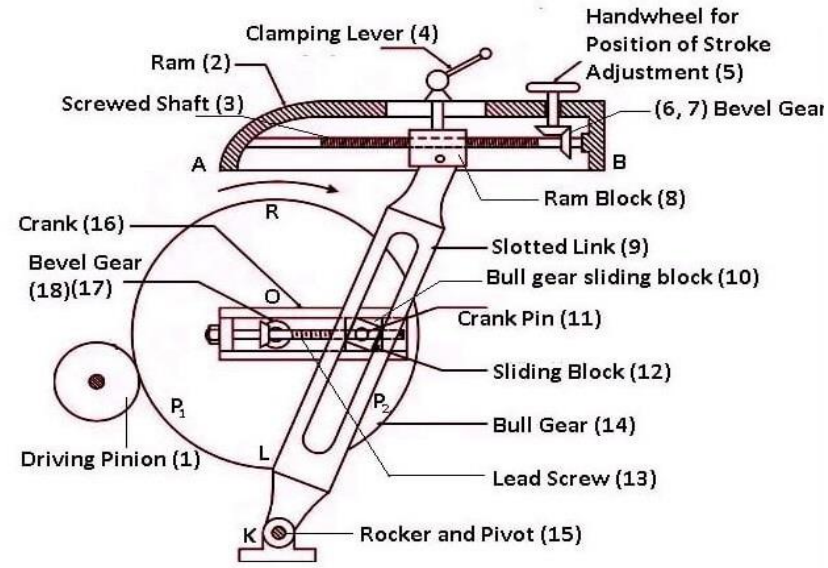
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of somequestions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q.1		Attempt any FIVE of the following:	10 Marks
	a) Ans	**Explain in short mechanics of chip formation.** Metal cutting involves excessive plastic deformation and fracture between the workpiece and wedge-shaped tool. Chip formation is localized shear process in a narrow region where the metal is compressed and made to flow on the face of the tool. As the tool advances, heavy forces are exerted, and material is cut when maximum shear stress is exerted along the shear plane. Finally, chip is formed. The basic two mechanisms involved in chip formation are, Yielding – generally for ductile materials Brittle fracture – generally for brittle materials	02 Marks
	b) Ans	**Enlist types of moulding sand.** 1. Greensand 2. Dry sand 3. Loam sand 4. Facing sand 5. Backing sand 6. Parting sand 7. Core sand	½ Mark for each(any four)
	c) Ans	**Differentiate between Soldering and Brazing (Any 4 points)**	

		SrNo	Soldering	Brazing	½ Mark for each
		1	It is a method of joining similar or dis-similar metals by using filler metal whose liquidus temp. is below 400 ºC	It is a method of joining two dis-similar metals by using filler metal whose melting point is above 400 ºC but lower than base metal	
		2	Filler metal is non ferrous metal or alloy. E.g.copper, zinc, aluminum alloy	Filler metals are usually lead, tin etc.	
		3	Comparatively weak joint is formed.	Relatively strong joint is produced.	
		4	Soldering methods-Soldering iron method, torch soldering, furnace, hot plate	Brazing methods- torch brazing, furnace brazing, resistance brazing	
		5	Applications- small Pipe fittings, electronic component joining	Applications- Carbide tipped tools, electrical connections	
	d)	**State applications of extrusion process.** (any 4 points) 1. Extrusion is widely used in production of tubes and hollow pipes. 2. Aluminum extrusion is used in structure work like Channel section, I-section, Z-section, T-section 3. This process is used to produce frames, doors, window etc. in automotive industries. 4. Extrusion is widely used to produce plastic objects. 5. Variety of cross-sectional shapes such as circular, square, rectangular, hexagonal (solid or hollow).			½ Mark for each
	e)	**Enlist Elements of tool signature in single point cutting tool.** The seven elements that comprise the signature of a single point cutting tool are always stated in the following order: 1. Back rake angle (0°) 2. Side rake angle (7°) 3. End relief angle (6°) 4. Side relief angle (8°) 5. End cutting edge angle (15°) 6. Side cutting edge angle (16°) and. 7. Nose radius (0.8 mm)			½ Mark for each (values of angle are not essential)

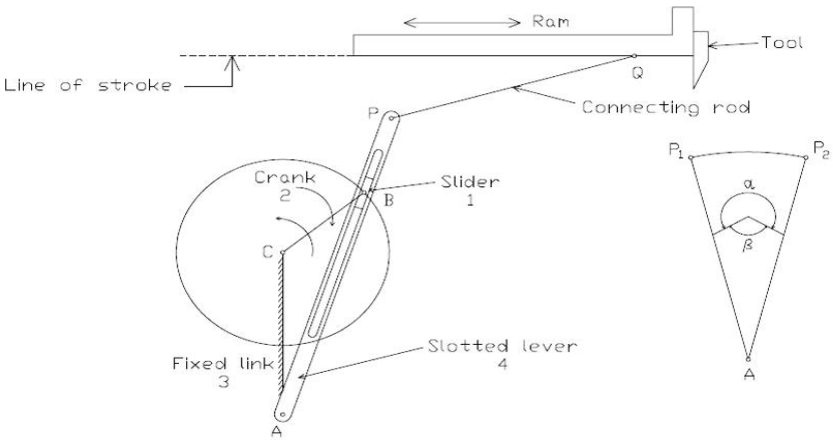
	f)	**Give classification of Shaping machines.** A] Types of shaper machine based on driving mechanism: 1. Crank type e.g., quick return motion mechanism 2. Geared shaper 3. Hydraulic shaper B] Based on ram travel: 1. Horizontal shaper 2. Vertical shaper 3. Travelling Head type C]Based on table design: 1. Standard or plain shaper 2. Universal shaper D]Types of shaping machine based on the cutting stroke: 1. Push type 2. draw cut type of shaper machine	01 Mark for 01 classification (Any 2 criterion of classification)
	g)	**State various elements of Gating system in moulding process.** 1. Pouring basin 2. Sprue or downsprue 3. Runner 4. Ingate 5. Riser	
Q. 2		**Attempt any <u>THREE</u> of the following:**	**12 Marks**
	a)	**State various types of chips and explain any one with sketch.** Mainly chips are of three types: - 1) Discontinuous chips. 2) Continuous chips. 3) Continuous Chips with built up edges (or BUE chips) 1. 2. **Discontinuous chips. :- (Segmental chips)**  Segmental chips **Segmental chips / discontinuous chips** If the chips during machining process is not continuous i.e. formed with breakage are called discontinuous chips. Discontinuous chips are formed when brittle or hard metals like brass, bronze and cast iron are used as workpiece in the machining process. Discontinuous chips are also formed in ductile material when the friction between tool and workpiece is high. Discontinuous chips is not a good sign for machining of ductile	04 01 Mark for types 03 Marks for explanation

		material as it gives poor surface finish and machining process becomes slow. **3. Continuous chips:**  Continuous chips are the chips formed during machining without breakage or without segments. These chips are formed by the continuous plastic deformation of metal without fracture in front of the cutting edge. Continuous Chips are mainly formed during cutting of ductile material like mild steel, aluminium and copper. 3. **Continuous Chip with Built Up Edge:**  This type of chip is similar to continuous chip and it has a built-up edge adjacent to the tool face and also is not as smooth as continuous edge. Actually, Built Up Edge (BUE) is an accumulation of work material against the rake face, that seizes to the tool tip, separating it from the chip. BUE is formed during machining of ductile metal when excessive friction exists between tool and workpiece. Built Up Edges are formed mainly due to friction between the tool and interface of chip. Because of friction between the tool and the chip, very intense heat is generated near the nose of the tool. The compressed metal near the nose of the tool gets welded due to high temperature near the nose. This compressed metal near welded to the nose is called built up edge, which is not desirable.	(Any one type to be explained)
	b)	**Sketch and explain Quick return mechanism in Shaping Machine** (ANY ONE SKETCH IS EXPECTED-Even sketch of Whitworth Quick return motion mechanism should be accepted)	04



02 Marks for sketch

OR



A quick return motion mechanism is used in the shaper and slotter machine in which the rotary motion is converted into reciprocating motion so that the slider moves forward and backwards, but return stroke (non- cutting stroke) is faster than forward (cutting stroke) stroke. In the forward direction, the cutting process occurs while in return there is no such cutting. The slider is free and it can slide in the slotted lever and the upper end of the slotted lever is attached to the ram of the shaper machine through a linkage. Now when the power is supplied, the crank starts rotating and the motion is transmitted to the slider and it is fitted inside the slotted lever therefore it starts oscillating.

Now ram moving forward and it travels through an angle α(Larger angle) whereas, In the return stroke, it travels through an angle β (Smaller angle).Thus, the idle time is reduced because of the fast-returning stroke.

02 Marks for explanation

	c)	**Differentiate between TIG and MIG welding.**	04

Sr.No	TIG welding	MIG Welding
1.	TIG stands for Tungsten Inert Gas Welding. It is also known as Gas Tungsten Arc Welding (GTAW).	MIG stands for Metal Inert Gas Welding. It is also known as Gas Metal Arc Welding (GMAW)
2.	It is a process in which an electric arc is formed in between a non-consumable tungsten electrode and workpiece metal.	It is a welding process in which electric arc is formed in between a consumable wire Electrode and workpiece metal.
3.	It uses constant current welding power supply for the welding.	Most commonly it uses constant voltage, direct current power source for the welding. It can also use constant current system and alternating current.
4.	It is most commonly used to weld stainless steels and non-ferrous metals like aluminum, magnesium and copper alloys.	The materials which it can weld are aluminum, non-ferrous materials and steels.
5.	High skilled operator is required to perform TIG welding process.	High skilled operator is not required to perform MIG welding process.
6.	It has low weld deposition rate as compared with MIG welding.	It has high weld deposition rate.
7.	It may require filler metal from outside in some cases depending on plate thickness.	No filler metal is required. The feed electrode wire melts and acts as filler metal.
8.	It can weld thin metal sheets upto 5 mm.	It can weld thick metal sheets upto 40 mm.
9.	It produces high quality of weld because it affords greater control over weld area.	It produces less quality of weld as compared with TIG.
10.	It is a slower welding process.	It is a faster welding process.

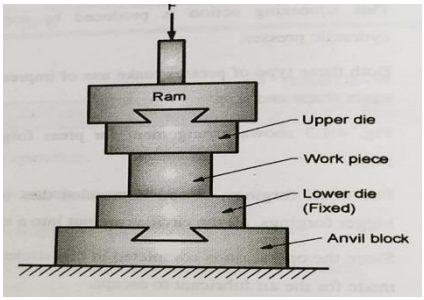
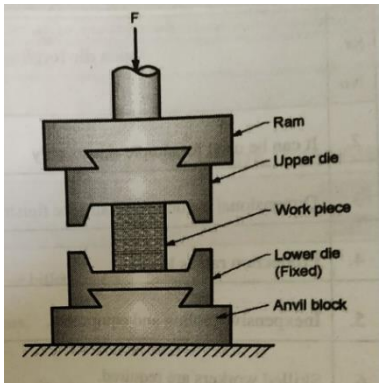
01 Mark for 01 Point

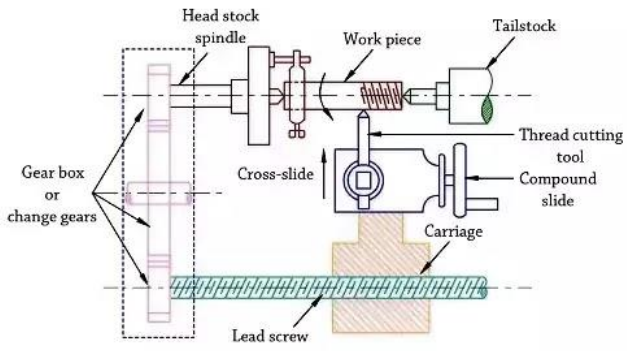
(any 4 points)

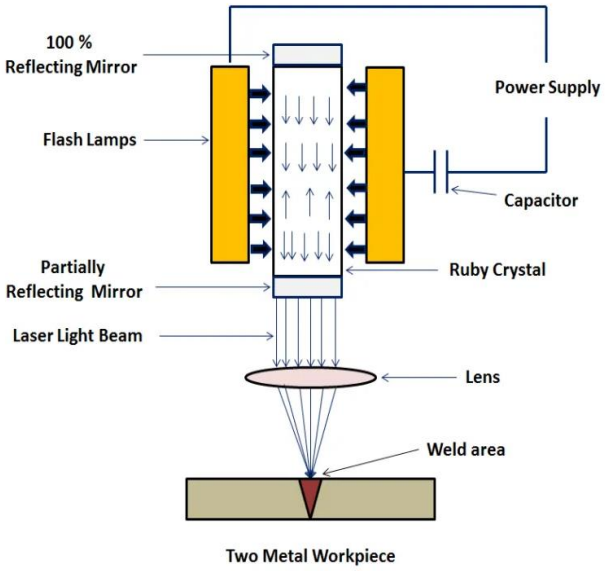
d) **Explain open and closed die forging operations.** 04

1. Open Die forging

(Sketch is not

		 Open die forging is the process, which involves the shaping of any hot metal parts. This is done with a top die that is attached to a ram and the bottom die gets attached to anvil block. Working surface of both upper and lower dies is flat and horizontal. The metal is constantly hammered and stamped to finally achieve a certain set of dimensions within the open die forging process. It gives poor accuracy and surface finish with low production rate. For this process, inexpensive tooling will work, but skilled worker is required. Open die forging helps in reducing the chances of voids. With the ability to provide continued grain flow, it can also help in generating finer grain size. It provides greater strength and improved microstructure. Steel and related alloys are generally subjected to open die forging. A lot of other metals like copper, nickel etc. can also be shaped using open die forging. **2. Closed die forging-**  Closed die forging, also known as an impression, generally confines the metal in dies. In this type of forging, cavities in the form of impressions are cut the die block. Closed dies are carefully machined matching blocks so as to produce forgings of accurate dimensions. During the forging, cavities in the die are completely filled. Excess metal is squeezed and escaped out in the form of thin fin or flash, which is removed while finishing. Closed die forging, can be entirely automated with minimal human involvement and a much simpler process in all. Complex shapes with greater accuracy and surface finish with high production rate can be produced. Skilled operator is not required. Disadvantages are high tooling cost and not suitable for production of small quantity.	mandatory) 02 Marks 02 Marks
Q.3		**Attempt any THREE of the following:**	**12 Marks**

	a)	**Explain with neat sketch thread cutting operation on lathe machine**. Threads can be cut on a cylindrical surface by forming or machining process Thread cutting by the machining process is done using a lathe. Threads of any pitch, shape and size can he cut on a lathe. The following figure shows the set-up of a lathe for thread.  **Lathe set-up for thread cutting operation** Thread cutting operation is done on a lathe using a single-point tool called thread cutting tool. The work piece is held between centres or in a chuck and the tool is held in tool post. For producing threads of pitch p mm, the tool must travel a distance equal to p [mm] as the workpiece makes one complete rotation. The definite relative rotary and linear motion between the workpiece and tool is achieved by locking or engaging the carriage with the lead screw through a screw and nut mechanism and fixing a gear ratio between the headstock spindle and lead screw. This is done by using change gear mechanism or gear box between the spindle and lead screw. To cut the threads, the tool is brought to the start of the workpiece and a small depth of cut is given to the tool using cross-slide. The carriage is engaged with the lead screw, the cut is made on the entire surface and at the end of the workpiece, carriage is disengaged. The tool is pulled out of the job and brought back to the starting position. The process is repeated until the full depth threads are obtained. The following relationship is used to determine the gears/wheels required to generate threads of definite pitch. Gearing ratio = Pitch of screw to be cut/Pitch of lead screw. = Lead of screw to be cut/Lead of lead screw threads = No. of teeth of driver/No. of teeth of driven Or = Driver/Driven	**04** 02 Marks for sketch 02 Marks for description
	b)	**Explain with neat sketch laser beam welding.**	04 02 Marks



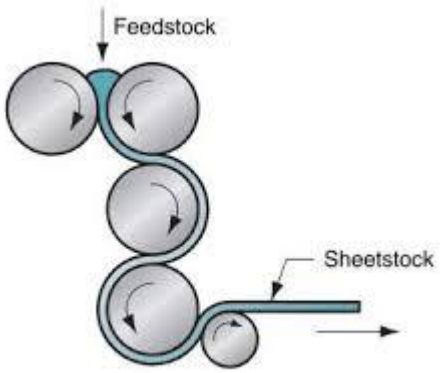
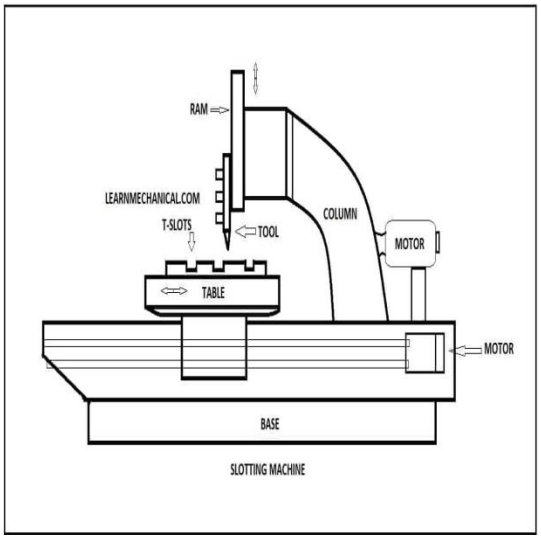
for sketch

02 Marks for description

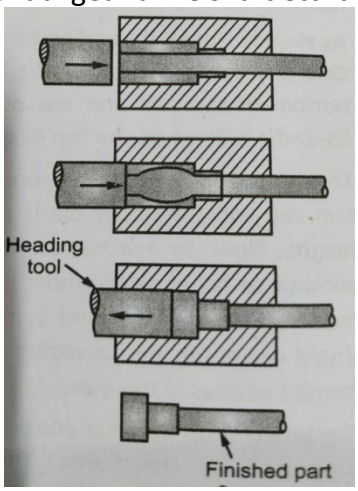
- First, the setup of welding machine at the desired location (in between the two metal pieces to be joined) is done.
- After setup, a high voltage power supply is applied to the laser machine. This starts the flash lamps of the machine and it emits light photons. The energy of the light photon is absorbed by the atoms of ruby crystal and electrons get excited to their higher energy level. When they return back to their ground state (lower Energy state) they emit a photon of light. This light photon again stimulates the excited electrons of the atom and produces two photons. This process keeps continue and we get a concentrated laser beam.
- This high concentrated laser beam is focused to the desired location for the welding of the multiple pieces together. Lens is used to focus the laser to the area where welding is needed. CAM is used to control the motion of the laser and work piece table during the welding process.
- As the laser beam strikes the cavity between the two metal pieces to be joined, it melts the base metal from both the pieces and fuses them together. After solidification, we get a strong weld.
- This is how a laser Beam Welding Works.

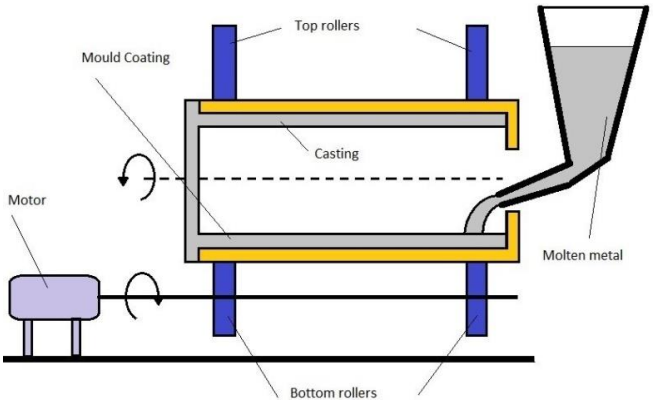
	c)	**Explain hot and cold rolling. State their applications.**	**04**
		Hot Rolling:-Hot rolling is a metalworking process in which metal is heated above the recrystallization temperature to plastically deform it in the working or rolling operation. This process is used to create shapes with the desired geometrical dimensions and material properties while maintaining the same volume of metal. The hot metal is passed between two rolls to flatten it, lengthen it, reduce the cross-sectional area and obtain a uniform thickness. Hot-rolled steel is the most common product of the hot rolling process, and is widely used in the metal industry either as an end product or as raw material for subsequent operations. **Cold Rolling:-**Cold rolling is a process which passes metal through rollers at temperatures below its recrystallization temperatures. This increases the yield strength and hardness of the metal.Cold rolling of metal strip is a special segment within the metalworking	01 Mark

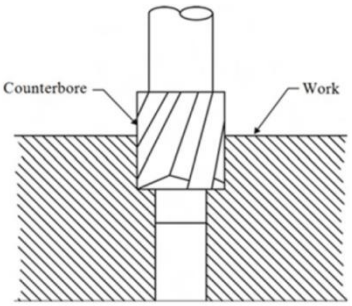
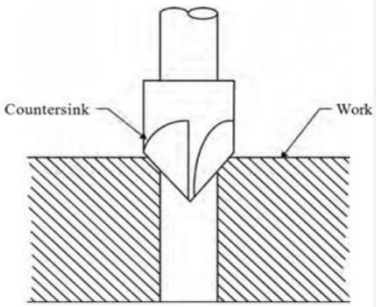
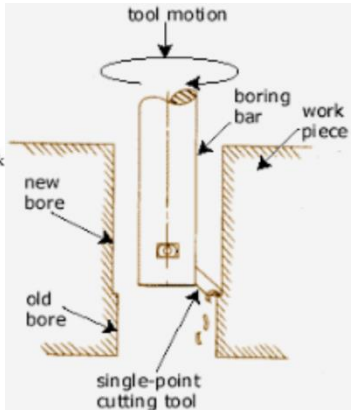
		industry.This is done by introducing defects into the crystal structure of the metal creating a hardened microstructure which prevents further slip. Because the meta is at room temperature, it is less malleable than metal above its recrystallization temperature. This makes cold rolling a more labour intensive and expensive process than hot rolling. Cold rolling can also reduce the grain size of the metal. Both hot rolling and cold rolling are used to create sheet metal. However, cold rolling produces thinner sheets. Hot rolling is also commonly used to create railroad rails, and cold rolling is often used to make beverage cans. **Applications of Hot-Rolling:-** • Automotive structural parts such as frames • Tabular products such as pipe and gas cylinders • Machine structures such as saws and springs • Agriculture equipment • Metal buildings • Guard rails **Applications of Cold-Rolling:-** • Metal furniture • Structural parts • Home appliances • Water heaters • Metal containers • Fan blades • Frying pans	01 Mark 01 Mark 01 Mark
	d)	**Explain calendaring process of plastic.** Calendering is the process of smoothing and compressing a material during production by passing a single continuous sheet through a number of pairs of heated rolls as shown in fig. The rolls in combination are called calenders. Calendering is a speciality process for high-volume, high quality plastic film and sheet, mainly used for PVC as well as for certain other modified thermoplastics. The melted polymer is subject to heat and pressure in an extruder and formed into sheet or film by calendering rolls. The temperature and speed of the rolls influences the properties of the film. Where it is squeezed into a sheet of uniform thickness, the finished product is cooled by passing through water cooled rolls. Calendering allows speciality surface treatments of the film or sheet such as embossing or enhancing the physical properties or in-line lamination.	**04** 03 Marks (Fig not asked if drawn given advantage)

		 Fig: Calendering Process	01 Marks
Q.4		**Attempt any <u>THREE</u> of the following:**	**12**
	a)	**Explain with basic diagram parts of slotting machine and state their functions.**  **1. Base or Bed** • The base is rigidly built to take up all the cutting forces and **the entire load of the machine.** • The top of the bed is accurately finished to provide guideways on which the saddle is mounted. • The guideways are perpendicular to the column face. **2. Column** • The column is the vertical member which is cast integrally with the base and houses driving mechanism of the ram and feeding mechanism. • The front vertical face of the column is accurately finished for providing ways in which the ram reciprocates. **3. Saddle**	**04** 02 Mark for sketch

		• The saddle is mounted upon the guideways and may be moved toward or away from the column either power or manual control to supply longitudinal feed to the work. • The top face of the saddle is accurately finished to provide guide ways for the cross-slide. These guideways are perpendicular to the guideways on the base. **4. Cross-slide** • The cross-slide is mounted upon the guideways of the saddle and maybe moved parallel to the face of the column. • The movement of the slide may be controlled either by hand or power to supply crossfeed. **5. Rotary Table** • The rotary table is a circular table which is mounted on the top of the cross-slide. • The table may be rotated by rotating a worm which meshes with a worm gear connected to the underside of the table. • The rotation of the table may be effected either by hand or power. • In some machines, the table is graduated in degrees that enable the table to be rotated for indexing or diving the periphery of a job in the equal number of parts. • T-slots are cut on the top face of the table for holding the work by different clamping devices. The rotary table enables a circular or contoured surface to be generated on the work piece. **6. Ram and Tool head Assembly** • The ram is the reciprocating member of the machine mounted on the guideways of the column. It supports the tool at its bottom end on a tool head. • A slot is cut on the body of the ram for changing the position of the stroke. • In some machines, special type for tool holders is provided to relieve the tool during its return stroke. **7. Ram Drive Mechanism** A ram removes metal during downward cutting stroke only, whereas during upward return stroke no metal is removed. To reduce the idle return time quick return mechanism is incorporated in the machine. slotter removes metal during downward cutting stroke only whereas during upward return stroke no metal is removed. The reduce the idle return time quick return mechanism is incorporated in the machine. The usual types of ram drive mechanism are, • Whitworth quick return mechanism. • Variable speed reversible motor drive mechanism. • Hydraulic drive mechanism.	02 marks explanation
	b)	**List out safety precaution to be taken in foundry shop.** 1. Even trace amounts of MOISTURE and MOLTEN METAL don't mix. Steam explosions are the number one cause of death in foundries. 2. NEVER put water on a metal fire. This can cause a HUGE EXPLOSION. 3. Have a DRY pile of sand and a shovel ready to put out fires or to control metal spills. 4. Have a sand bed under all areas. Always use earplugs to safeguard against the heavy	**04**

		noise. The sand bed should be at least 3 inches thick. This will help in containing metal spills and will help protect flooring. 5. Never pour over wet ground. Remember, even TRACE AMOUNTS of MOISTURE can cause EXPLOSIONS. 6. Molten metal spilled on concrete will cause the concrete to explode. Use a thick sand bed over concrete. 7. Always use clean metal as feedstock. Combustion residues from some lubricants and paints can be very toxic. 8. Always operate in a well-ventilated area. Fumes and dusts from combustion and other foundry chemicals, processes and metals can be toxic. 9. Use a NIOSH rated dusk mask. Dusts from sand, parting dusts and chemicals can be hazardous or cancer causing. Protect your lungs. 10. Always use safety glasses. Even minor mishaps can cause blindness. 11. Never use a crucible that has been damaged or dropped. It's just not worth the risk. Imagine what would happen if a white-hot crucible of brass crumbled as you were carrying it. 12. Always charge crucibles when cold. Adding metal to a hot crucible is really dangerous. If there is moisture on the metal, even just a haze, the metal can cause the entire contents of the crucible to explode. 13. Spilled molten metal can travel for a great distance. Operate in a clear work area. 14. One should not touch hot moulds and castings. 15.All foundry men should wear protective clothes, glasses, shoes, and gloves while handling molten metal.	½ for each point(any eight)
	c)	**Explain with sketch upset forging operation.** These forging operations are done to increase the cross-sectional area of the workpiece to expand the length. The force is applied in a parallel direction of the long axis. A good example of an upsetting operation is a bolt head. In upset forging a heated bar of metal is inserted between the movable and stationary halves of the set of dies. The amount of stock to be upset is set by the stop gauge. The stop is then moved away and the stock is then gripped between the female dies by bringing the moving die close to the stationary die. A punch is then forced against the workpiece, forming and enlarging the end of the workpiece to take the shape of the die cavity. For smaller job sizes, upsetting is generally done in the cold condition e.g. bolts, rivets, pins etc. For larger sizes of jobs like valves, rear axle half-shafts and differential gear drive shaft etc. the stock is heated.  	**04** 02 marks explanation

			02 Marks fig.
	d)	**State various applications of extrusion processes.** • Extrusion is widely used in production of tubes and hollow pipes. • Aluminium extrusion is used in structure work in many industries. • This process is used to produce frames, doors, window etc. in automotive industries. • Extrusion is widely used to produce plastic objects. • Electrical wires, bars and tubes are some of the items produced by hot extrusion. Collapsible tubes, gear blanks, aluminium cans, cylinders are some of the items produced by cold extrusion.	**04** 01 Mark for each applications (any four)
	e)	**Explain centrifugal casting method with neat sketch.**  Centrifugal casting, sometimes called rotocasting, is a metal casting process that uses centrifugal force to form cylindrical parts. This differs from most metal casting processes, which use gravity or pressure to fill the mold. In centrifugal casting, a permanent mold made from steel, cast iron, or graphite is typically used. However, the use of expendable sand molds is also possible. The casting process is usually performed on a horizontal centrifugal casting machine (vertical machines are also available) and includes the following steps: 1. Mold preparation - The walls of a cylindrical mold are first coated with a refractory ceramic coating, which involves a few steps (application, rotation, drying, and baking). Once prepared and secured, the mold is rotated about its axis at high speeds 2. Pouring - Molten metal is poured directly into the rotating mold, without the use of runners or a gating system. The centrifugal force drives the material towards the mold walls as the mold fills. 3. Cooling - With all of the molten metal in the mold, the mold remains spinning as the metal cools. Cooling begins quickly at the mold walls and proceeds inwards. 4. Casting removal - After the casting has cooled and solidified the rotation is stopped and the casting can be removed. 5. Finishing - While the centrifugal force drives the dense metal to the mold walls, any less dense impurities or bubbles flow to the inner surface of the casting. As a result, secondary processes such as machining, grinding, or sand-blasting, are required to clean and smooth the inner diameter of the part.	**04** 02 Mark for sketch 02 marks explanation

		Centrifugal casting is used to produce axi-symmetric parts, such as cylinders or disks, which are typically hollow. Due to the high centrifugal forces, these parts have a very fine grain on the outer surface.. These parts may be cast from ferrous metals or from non-ferrous alloys. Broadly, centrifugal casting can be classified into true centrifugal casting, semi-centrifugal casting and centrifuging. Centrifugal casting is performed in wide variety of industries, including aerospace, industrial, marine, and power transmission. Typical parts include bearings, bushings, coils, cylinder liners, nozzles, pipes/tubes, pressure vessels, pulleys, rings, and wheels.	
Q.5		**Attempt any <u>TWO</u> of the follwing**	**12**
	a)	**Explain Various drilling machine operations with neat sketch. (At least three)** **i) Counterboring:-**Counterboring is the operation of enlarging the end of a hole with a hole cylindrically. Counterbores provide a shoulder to accommodate the heads of bolts, studs, and pins. The tool used for counterboring is called a counterbore. The cutting edges may have straight or spiral teeth. The cutting speed for countersinking is 25% less than that of drilling operation.  Fig Counterboring Operation  Fig Countersinking Operation  **ii) Countersinking:-**Countersinking is the operation of producing a taper or cone shape surface at the entrance of a hole for the purpose of having the head of a flat head screw, aviation rivet or other similar fastener sit flush or below a surface. This cone shape is machined with tool called countersink. Countersinks are available as a single flute or multi flute. A variety of sizes and included angles of: 60°, 82°, 90°, 100°, 110°, and 120° are available. The cutting speed for countersinking is 25% less than that of drilling operation. **iii) Boring operation:**In machining, boring is the process of enlarging a hole that has alreadybeen drilled (or cast) by means of a single-point cutting tool , such as in boring a gun barrel or an engine cylinder. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal - diameter counterpart to turning, which cuts external diameters.	**06** 02 Marks (01 m fig. 01 m explanation) 02 marks 02 Marks
	b)	**Explain direct and indirect extrusion. State their advantages and disadvantages.** **Direct extrusion (also called forward extrusion) :** A metal billet is loaded into a container, and a ram compresses the material, forcing it to flow through one or more openings in a die at the opposite end of the container. As the ram approaches the die, a small portion of the billet remains that cannot be forced through the die opening. This extra portion, called the butt, is separated from the product by cutting it just beyond the exit of the die. One of the problems in direct extrusion is the significant friction that exists	**06**

between the work surface and the walls of the container as thebillet is forced to slide toward the die opening. This friction causes a substantial increase in the ram force required in direct extrusion.

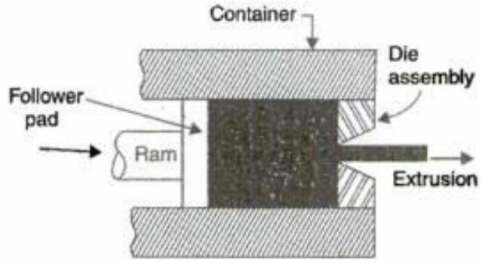
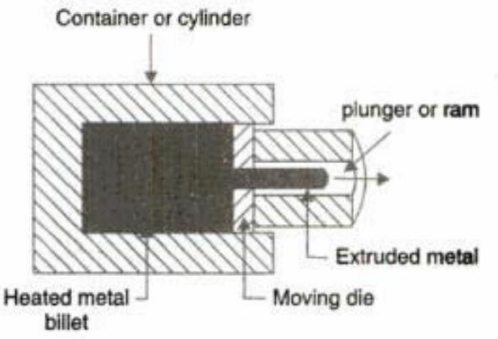


Fig not essential if drawn should be given advantage

01 Mark

Indirect extrusion (also called backward extrusion and reverse extrusion):
The die is mounted to the ram rather than at the opposite end of the container. As the ram move, the metal is forced to flow through the clearance in a direction opposite to the motion of the ram. Since the billet is not forced to move relative to the container, there is no friction at the container walls, and the ram force is therefore lower than in direct extrusion.



01 Mark

Advantages of Direct Extrusion:-

1) close tolerance can be achieved with production of long shells
2) Direct extrusion can be employed for extruding solid circular or non-circular sections, hollow sections such as tubes or cups

Disadvantages of Direct Extrusion:-

1) Friction between the container and billet is high
2) greater forces are required. 3) The corresponding extrusion pressure is also higher because of friction between container and billet.

Advantages of Indirect Extrusion:-

01 Mark

1) there is less friction between the container and billet.
2) Less forces are required for indirect extrusion.
3) Indirect extrusion can produce hollow (tubular) cross sections,

Disadvantages of Indirect Extrusion:-

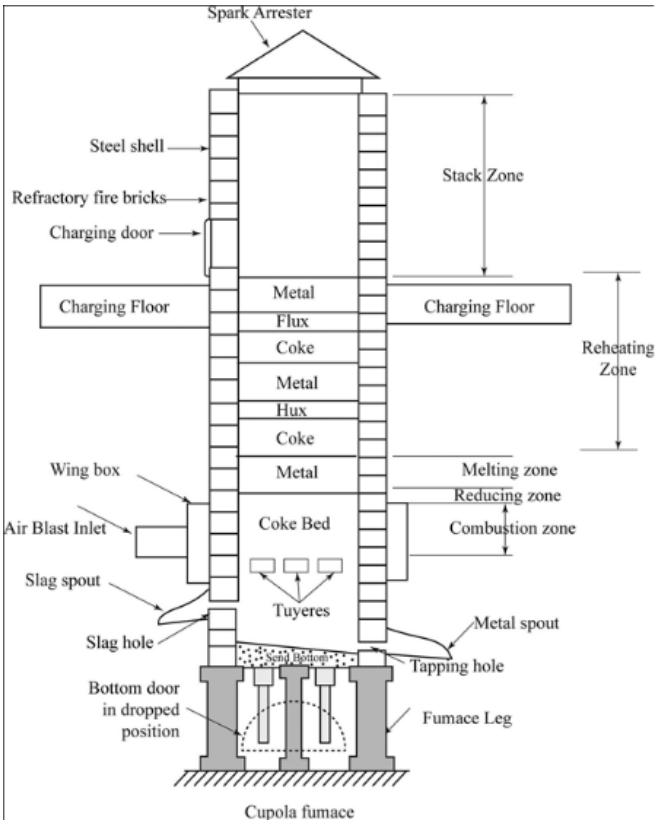
01 Mark

1) Indirect extrusion cannot be used for extruding long extrudes.
2) Support of the ram becomes a problem as work length increases.

01 Mark

01 Mark

	c)	**List Out various casting defects and state their remedies.** **Casting Defects and remedies:-** **[1] Blow holes:** It is smooth sound cavities produced in a casting due to entrapped bubbles of gases, steam. ***Remedies:-*** i) Moisture content of the sand must be well. ii) Sand of proper grain size should be used. iii) Ramming should not be too hard. iv) Vent holes should be provided. **[2] Mis-run and cold shut:-**When molten metal fails to fill the entire cavity of the mould, incomplete casting is obtained. This defeat is called mis-run and imperfect fusion of two stream of molten metal in the mould cavity results in a discontinuity called cold-shut. ***Remedies:-*** i) Use hotter metals ii) Frequent inspection and replacement of pattern. iii) Proper design of gating and raiser iv) Use of chills and padding. **[3] Drop: -** This is an irregular deformation of the casting produced when a portion of the sand drops into the molten metal. ***Remedies:*** i) These can be controlled by adopting proper moulding, gating and melting techniques. **[4] Dirt: -** Presence of particles of dirt and sand in the casting. ***Remedies:-*** i) Proper handling of mould ii) Adopting proper moulding, gating and melting techniques. iii) Proper design of gating and raiser iv) Use of chills and padding **[5] Shifts: -** It is a misalignment of top and bottom parts of mould at parting line. This results in mismatch of the casting, incorrect dimension, incorrect location of holes. ***Remedies:-*** i) ensuring proper alignment of the pattern, moulding boxes ii) correct mounting of pattern on pattern plates etc **[6] Fins and flash: -** It is a thin metal projection on casting. ***Remedies:-*** i)These can be controlled by adopting proper moulding, gating and melting techniques. ii) insufficient weight should be placed on the top part of the mould **[7] Swell: -** It is un-intentional enlargement found on the casting surface due to liquid	**06** 01 Mark for each any six

		metal pressure. ***Remedies:-*** i) Proper ramming of sand ii) uniform flow of molten metal into the mould **[8] Run-out: -** This defect occurs when molten metal leaks out to the mould during pouring. It results in incomplete casting. ***Remedies:-*** i) The corrective measures taken in respect of the above reasons will prevent this defect. **[9] Warpage: -** This is unintentional and undesirable deformation of casting produced during solidification of metal. ***Remedies:-*** i) This defect can be eliminated by modifying the casting design and proper directional solidification. **[10] Hot tears (Hot Cracks):-**These are internal or external cracks resulting immediately after the solidification of metal. ***Remedies:-*** i) abrupt change in section should be avoided ii) Pouring temperature should be correct iii) There should be even rate of cooling.	
Q.6		**Attempt any <u>TWO</u> of the following**	**12**
	a)	**Explain construction and working of cupola furnace.**  	**06** 02 Mark for diagram 02 m for constructio n 02 m for working

Construction: - Cupola Furnace is a melting device which used to melt cast iron, Bronze and other alloying elements are melted. It is mainly used to convert pig iron to cast iron. Cupola Furnace was first built in China in the Warring States Period (403 -221 BC). Cupola furnace is cylindrical in shape and the equipment of this furnace is vertically fitted inside this cylindrical shell with doors.

For many years Cupola Furnace was used to melt iron in iron foundries because it produces good Cast iron from Pig Iron. The outermost part of cupola furnace is cylindrical steel shell. The diameter of this shell ranges from 1.5 to 13 feet depending upon the size of the furnace. The inner side of the furnace is lined withrefractory brick and plastic refractory patching material.

This furnace is supported on Cast iron legs mounted on concrete base. At the bottom of the furnace, two cast iron doors are hinged with the bed plate of the furnace. Near the bottom, it has send bed above which the melted iron flow. This sand bed is tapered. Near the elevated side of the tapered sand bed, slag hole is present through which slag formed from impurities comes out. Near the downside of the down bed, the tap hole is present through which molten iron comes out.

Above the send bed, tuyers are present through which air reaches the furnace and helps in combustion.

At the top of the furnace spark arrester or cap is present that traps the burning particles and only allow the gases to release to the environment.

Near the top of the furnace, charging door is present through which metal, coke and lime stone are fed into the furnace.

Working of Cupola Furnace :

At first wood is ignited above the sand bed. When the wood starts burning properly, coke is dumped on the well from the top to a predetermined height of nearly 40 inches. This forms a 40 inch coke bed.

Then the combustion starts in the coke bed using the fire from the burning wood and using the air from the tuyers. At this time, the air blast is turned out at a lower blowing rate than normal to provoke the coke.

After nearly 3 hours of burning when the coke starts burning properly, alternate layers of limestone, pig iron and coke is charged until it reaches the level of charging door is reached. At this time the air blast is tuned on to normal blowing rate and the combustion occurs more rapidly in the coke bed.

All oxygen from the air blast is consumed by the combustion in the combustion zone.The chemical reaction which takes place is,

C + O2 -> CO2 + Heat

This is an exothermic reaction and in the combustion zone the temperature varies from 1150 to 1850 degree Celcius.

The portion of the coke bed above the combustion zone is reducing zone. This zone prevent the oxidation of metal charge above and while dropping through it.As the ho carbon dioxide moves up through this zone, some of it is reduced by the following reaction,

CO2 +C -> 2CO

The layer of iron above reducing zone is melting zone where the solid iron is converted into molten iron.This melted iron trickles down through the coke bed and is collected in the well. Sufficient carbon comtent is picked up by the molten metal in this zone and is represented by the chemical reaction given as :-

3 Fe + 2 CO —> Fe3 C + CO2

Above the melting zone, there is preheating zone where the charge is preheated by the outgoing gases and the temperature of this zone is about 1900 degree Celcius.

Apart from limestone, fluorspar and soda ash are also used as flux material. Main function of flux is to remove impurities from iron and protect iron from oxidation.
Within 5 to 10 minutes of starting of air blast to normal blowing rate , the first molten iron appears at the tap hole.

b) Explain Taper turning operation on lathe machine with neat sketch. — **06 Marks**

Taper Turning:-

A taper is defined as a uniform increase or decrease in diameter of a piece of work measured along its length. In a lathe machine, taper turning means to produce a conical surface by gradual reduction in diameter from a cylindrical job. A taper is generally turned in a lathe by feeding the tool at an angle to the axis of rotation of the workpiece. The angle formed by the path of the tool with the axis of the workpiece should correspond to the half taper angle. A taper can be turned by anyone of the following methods:

Methods of taper turning — 03 marks fig

- By a broad nose form tool
- By setting over the tailstock Centre
- By swiveling the compound rest
- By taper turning attachment
- By combining longitudinal and cross feed in lathe

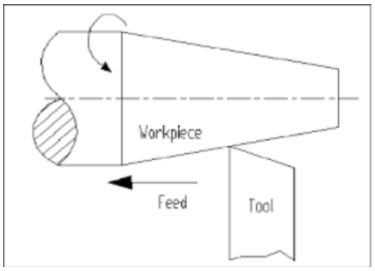


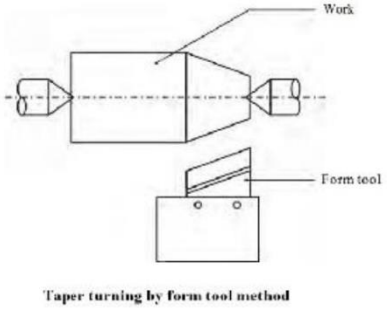
Figure :- Taper Turning

03 marks explanation

Explanation:

1. **Form tool method**:

This is one of the simplest methods to produce short taper. To the required angle the form is grounded and used. The tool is fed perpendicular to the lathe axis, when the work piece rotates.

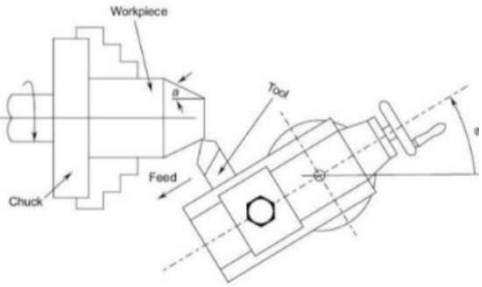


Taper turning by form tool method

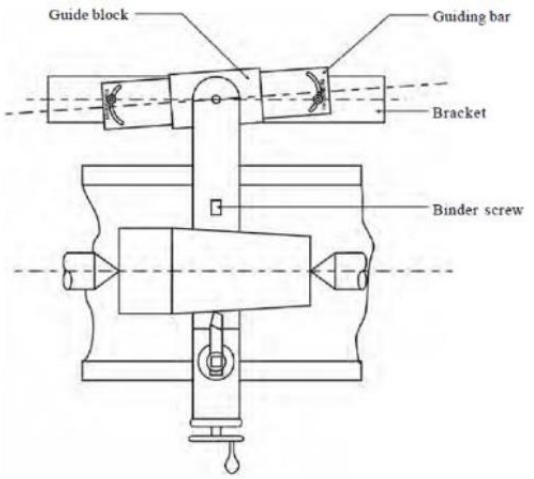
3. Compound rest method:

Generally short and steep taper are produced using this method. In this method the work piece is held in the chuck and it will be rotated about the lathe axis. The compound rest is

swiveled to the required angle and then it will be clamped in position.

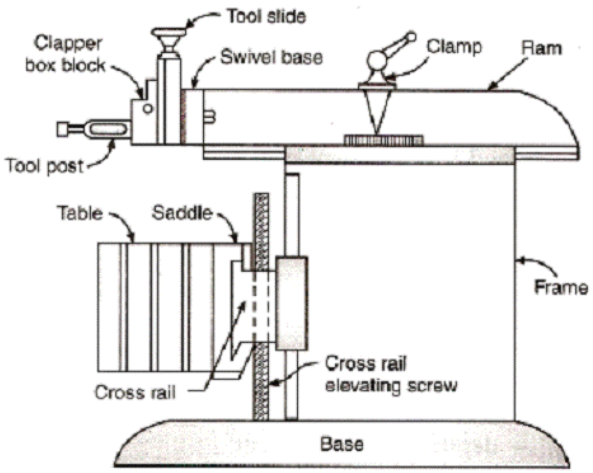


4. Taper turning attachment method:
In this method by using bottom plate or bracket, a taper turning attachment is attached to the rear end of the bed. It has a guiding bar which is usually pivoted as its center. The guiding bar has the ability to swing and it can be set in any required angle. It has graduations in degrees. It has a guide block which connects to the rear end of the cross slide and it moves on the guide bar. The binder screw is removed, before connecting the cross slide, hence the cross slide is free from the cross slide screw.



Taper turning by taper attachment method

c) Explain with neat sketch working principle of shaping. **6 Marks**



03 m fig

The shaper is a machine tool used primarily for:

		1. Producing a flat or plane surface which may be in a horizontal, a vertical or an angular plane. 2. Making slots, grooves and keyways 3. Producing contour of concave/convex or a combination of these The main parts of the Shaper machine is Base, Body (Pillar, Frame, Column), Cross rail, Ram and tool head (Tool Post, Tool Slide, Clamper Box Block). **Base**: The base is a heavy cast iron casting which is fixed to the shop floor. It supports the body frame and the entire load of the machine. The base absorbs and withstands vibrations and other forces which are likely to be induced during the shaping operations. **Body (Pillar, Frame, Column):** It is mounted on the base and houses the drive mechanism compressing the main drives, the gear box and the quick return mechanism for the ram movement. The top of the body provides guide ways for the ram and its front provides the guide ways for the cross rail. **Cross rail:** The cross rail is mounted on the front of the body frame and can be moved up and down. The vertical movement of the cross rail permits jobs of different heights to be accommodated below the tool. Sliding along the cross rail is a saddle which carries the work table. **Ram and tool head:** The ram is driven back and forth in its slides by the slotted link mechanism. The back and forth movement of ram is called stroke and it can be adjusted according to the length of the workpiece to be-machined. **Working Principle:** The job is rigidly fixed on the machine table. The single point cutting tool held properly in the tool post is mounted on a reciprocating ram. The reciprocating motion of the ram is obtained by a quick return motion mechanism. As the ram reciprocates, the tool cuts the material during its forward stroke. During return, there is no cutting action and this stroke is called the idle stroke. The forward and return strokes constitute one operating cycle of the shaper	03 m explanation

END

22446

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Figures to the right indicate full marks.

(4) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Explain in short mechanics of chip formation.

b) Enlist types of moulding sand.

c) Differentiate between soldering and brazing.

d) State applications of extrusion process.

e) Enlist elements of tool signature of single point cutting tool.

f) Give classification of shaping machines.

g) State the various elements of gating system in moulding process.

2. Attempt any THREE of the following: **12**

a) State various types of chips. Explain any one with neat sketch.

b) Explain with sketch quick return mechanism used in shaping machine.

c) Differentiate between TIG and MIG welding. (atleast four points)

d) Explain open and closed die in forging operations.

P.T.O.

Marks

3. Attempt any THREE of the following: **12**

a) Explain with neat sketch thread cutting operation on lathe machine.

b) Explain with neat sketch laser beam welding.

c) Explain hot and cold rolling. State their applications.

d) Explain calendering process of plastic.

4. Attempt any THREE of the following: **12**

a) Explain with basic diagram parts of slotting machine and state their functions.

b) List out safety precaution to be taken in foundry shop.

c) Explain with sketch upset forging operation.

d) State various application of extrusion processes.

e) Explain centrifugal casting method with neat sketch.

5. Attempt any TWO of the following: **12**

a) Explain various drilling machine operation with neat sketch. (atleast three)

b) Explain direct and indirect extrusion. State their advantages and disadvantages.

c) List out various casting detects and state their remedies.

6. Attempt any TWO of the following: **12**

a) Explain construction and working of cupola furnace.

b) Explain Taper turning operation on lathe machine with neat sketch.

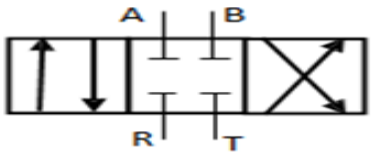
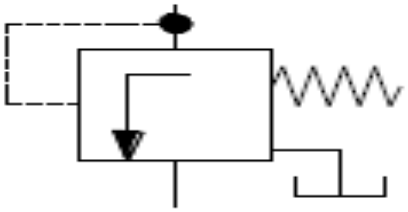
c) Explain with neat sketch working principle of shaping.

WINTER – 2022 EXAMINATION
Model Answer

Subject Name: Industrial Hydraulics and Pneumatics **Subject Code:** 22655

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE 0f the Following**	10
	a)	Draw IS symbol for	01 marks each
		i) 4/3 Directional control Valve	
		i) Sequence Valve	

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td></td><td>b)</td><td>I)Viscosity: - The viscosity of a fluid is a measure of its resistance to shear or angular deformation.

Or Viscosity is a measure of a fluid's resistance to flow.

ii)Specific Weight :- Specific weight is defined as weight per unit volume</td><td>01 marks each</td></tr>
<tr><td></td><td>c)</td><td><table><tr><td>Linear Actuator</td><td>Material Handling. Robotics. ...
Food and Beverage Manufacturing. ...
Window Automation. ...
Agricultural Machinery. ...
Cutting Equipment. ...
Valve Operation</td></tr><tr><td>Rotary Actuator</td><td>Clamps or pick-and-place handlers farm applications for rotating arms, booms in industries for positioning, transferring & clamping parts.</td></tr></table></td><td>01 marks each (Minimum 2 application of each.</td></tr>
<tr><td></td><td>d)</td><td>Factors to be considered while selecting pump

1. Liquid Properties-
2. Pump Capacity (Flow Rate and Pressure of oil)
3. Efficiency of the pump
4. Speed of pump
5. Ease of Use
6. Environmental Considerations
7. Control Systems</td><td>Minimum 4 , half each.</td></tr>
<tr><td></td><td>e)</td><td>Different functions of valves

1 Industrial system, and in any piping system, valves are used to restrict stop or control the flow of fluid.

2 Regulating flow and pressure within a piping system.

3 Controlling the direction of flow within a piping system

4 Throttling flow rates within a piping system.</td><td>Minimum 2 , 1 each.</td></tr>
</table>

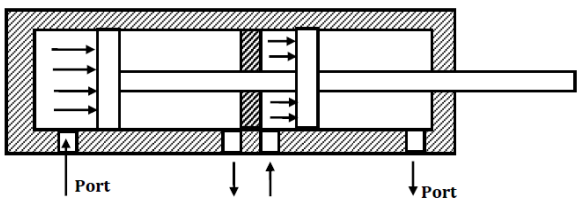
	f)		Minimum 4 , half each.

Hydraulic Filter	Pneumatic **Filter**
Suction Filters and Strainers	Air Filter Types **Fiberglass, polyester, washable, pleated and electrostatic filters**
Spin-On Filters	Water separators.
Reservoir Breather Filters	Particulate filters.
	Adsorbing filters.

	g)	Common faults that can be observed in Pneumatic System i) Low pressure ii) High Temperatures iii) Particulate Contamination iv) Compressor Stalling, Failure, And Faults v) Audible And Visible Leaks.	Minimum 4 , half each
2	a)	**Attempt Any THREE of the following:**	12
		Advantages and limitations of hydraulic and pneumatic systems (reference points)	2 marks each

Parameters	**hydraulic systems**	**pneumatic systems**
Complexity	Moderately complex system	Simple system
Peak Power	Very high	high
Speed	Moderate	Very high
Load Ratings	Very high	high
Environmental	Low	High noise levels
Purchase Cost	High	low
Operating Cost	High	Moderate
Maintenance Cost	High	low

b) **Tandem Cylinder:-** 02+02

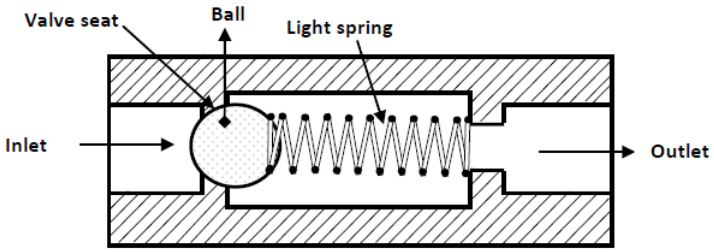


A tandem cylinder, shown in Figure , is used in applications where a large amount of force is required from a small-diameter cylinder. Pressure is applied to both pistons, resulting in increased force because of the larger area. Hence at the piston rod, we can get double force during movement of pistons.

c) **Check valve** — 02+02

The simplest DCV is a check valve. A check valve allows flow in one direction, but blocks the flow in the opposite direction. It is a two-way valve because it contains two ports.

In Figure light spring holds the ball against the valve seat. Flow coming into the inlet pushes the ball off the seat against the light force of the spring and continues to the outlet. A very low pressure is required to hold the valve open in this direction. If the flow tries to enter from the opposite direction, the pressure pushes the ball against the seat and the flow cannot pass through.

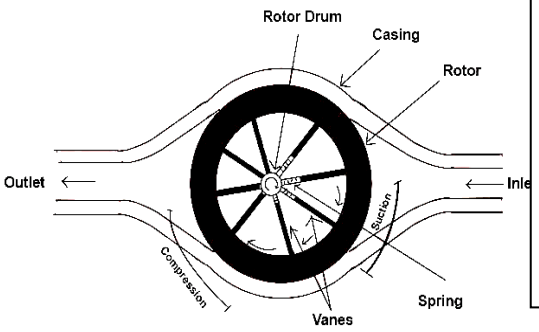


d) **Any one rotary compressor with sketch** — 02+02

Rotary compressor units are classified into three general groups, (Any one)

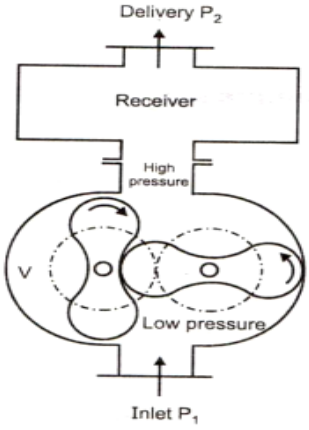
1. Slide vane-type,
2. Lobe-type, and
3. Screw-type.

Slide vane-type,



- This is a positive-displacement pump that consists of vanes mounted to a rotor that rotates inside a cavity.
- The vane-type compressor consists of a cylindrical rotor with longitudinal slots in which radial sliding vanes are fitted.
- The rotor is positioned eccentrically within a cylindrical housing.
- The spaces between adjacent vanes form pockets of decreasing volume from a fixed inlet port to a fixed discharge port.

Lobe-type



Lobe type air compressor: it is a rotary type of compressor consisting of two rotors which are driven externally.
One rotor is connected to drive and second is connected to gear. These two rotors have two or three lobes having epicycloids, hypocycloid or involutes profiles.
In the figure two lobes compressor is shown with a inlet arrangement and receiver. A very small clearance is maintained between surfaces so that wear is prevented.
Air leakage through this clearance decreases efficiency of this compressor. During rotation a volume of air V at atmospheric pressure is trapped between left hand rotor and casing . this air is positively displaced with change in volume until space is opened to high pressure region.
At this instant some high pressure air rushes back from the receiver and mixed with the blower air until both pressure are equalized.

Screw type

In a screw compressor one of the shafts is driving shaft and the other is driven shaft. The driving shaft is connected to the driven shaft via timing gears which help to match speeds of both the shafts. The driving shaft is powered by an electric motor generally. The two shafts are enclosed in an airtight casing.

The working cycle of the screw compressor has three distinct phases as following:

i) Suction process

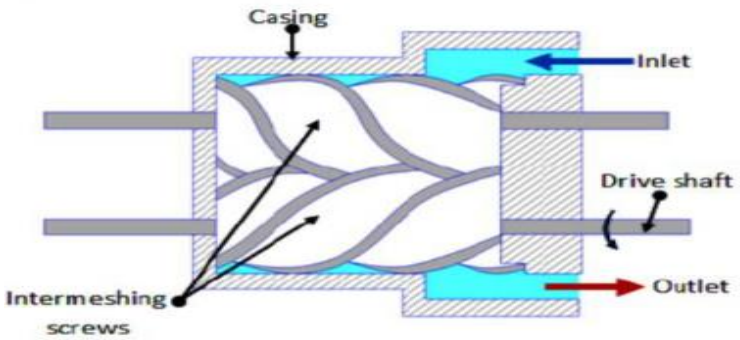
ii) Compression process

iii) Discharge process.

i) **Suction process** - As the rotors rotate, air is drawn through the inlet opening to fill the space between the male lobe and the female flute.
As the rotor continues to rotate, the air is moved past the suction port and sealed in the interlobe space.

ii) **Compression process** -As the main rotor turns, the air trapped in the ineterlobe space is moved both axially and radially.
The air is compressed by direct volume reduction as the enmeshing of the lobes progressively reduced the flute volume and compression occurs.

iii) **Discharge process:** At a fixed point where the leading edge of the flute and the edge of the discharge port co-inside, compression ceases and the air is discharged into the delivery line, until the flute volume has been reduced to zero.



3 **Attempt Any THREE of the following:** 12

a) **Compare gear pump and vane pump on the basic of:-** 01 mark each

Parameters	Gear pump	Vane pump
Construction	Construction Simple in construction than vane Pump.	Complex in construction.
Speed	1200 to 2500 RPM	1200 to 1800 RPM
Application	Pumping high viscosity fluids such as oil, paints, resins or foodstuffs	High-pressure hydraulic pumps and in automobiles, including supercharging, power-steering, air conditioning, and automatic-

		transmission pumps.	
	Pressure	35 to 200 Bar	70 to 140 Bar

b) **Explain the working of sequence valve with neat sketch.** — 02 +02

A primary function of sequence valve is to direct flow to different components of the circuit in a predetermined sequence. It is a pressure actuated valve which senses a certain change in pressure from the set value. It then takes the actions to direct the fluid in a definite predetermined order. It also maintains the requisite minimum pressure in the primary line while the secondary operations occur.

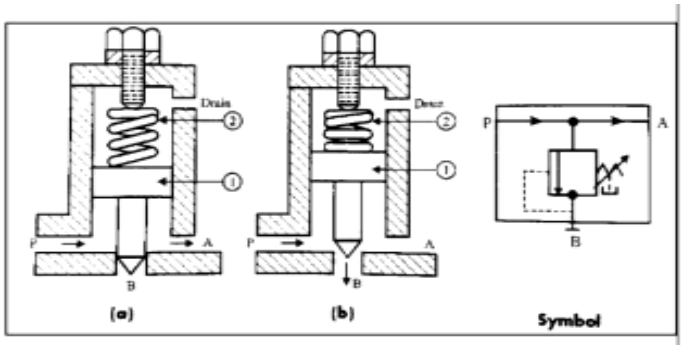


Figure shows operating principle of a direct acting, normally closed sequence valve. In this position, fluid passes through the valve from the inlet port P to primary outlet port A at system pressure. When the first step in the sequence is completed, the system pressure increases to act against the exposed area of the piston. Continued increase in pressure causes the piston to compress the spring and unseat the valve, thereby directing the flow of fluid at high pressure through secondary outlet port B. Fluid pressure is maintained in both branches of the circuit so long as the sequence valve is open. Adjustment of the sequence valve is accomplished by compressing or extending the piston with the cap screw.

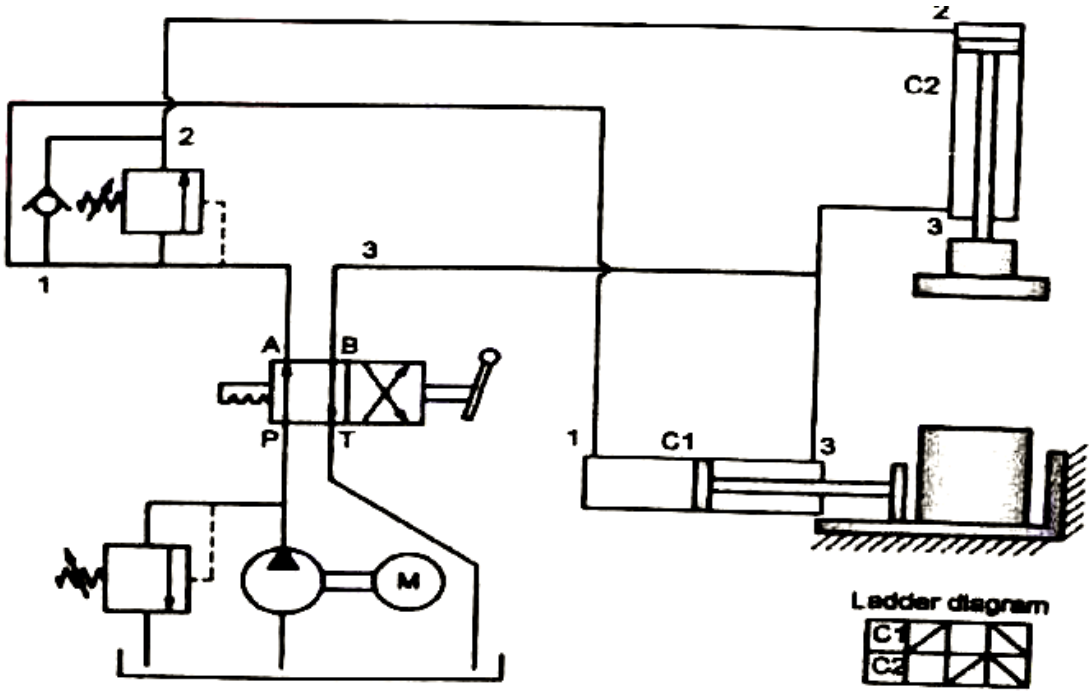
c) **Compare meter in and meter out Circuit.** — Any 04 points (01 mark each)

Sr No	Meter-IN	Meter-OUT
1	When a pressurized oil flow through the circuit it passes through D. C. valve and enters in the flow control valve. The opening of the flow control valve is reduced to decrease the oil flow rate. Control of piston is achieved only in advance stroke.	When oil flow from pump to the actuator through D.C. valve it will push the piston in the forward direction. The oil from the piston rod side is pushed through the outlet of B of D.A. Cylinder through the return line
2	Flow control valve 'F' is placed in pressure line	Flow control valve 'F' is placed in return line
3	Give best result when used in higher pressure systems.	The actuator movement is very stable
4	Relatively small friction to face by piston which increases life of piston	Heat generated due to throttling at flow control valve is given to the oil tank.
5	Suitable for very low piton rod speeds	Provides positive speed control of the cylinder
6	Throttling of fluid takes place which heats the oil and hot oil into admitted into cylinder	Since both sides of piston there is pressure, there is possibility of higher friction.

7	The circuit is used where finer speed control is required.	This circuit is used where very stable movements of actuators are needed.	
8	Used in - Surface grinders, Welders, Milling Machines	Used in - Drilling, boring, reaming and tapping operations	

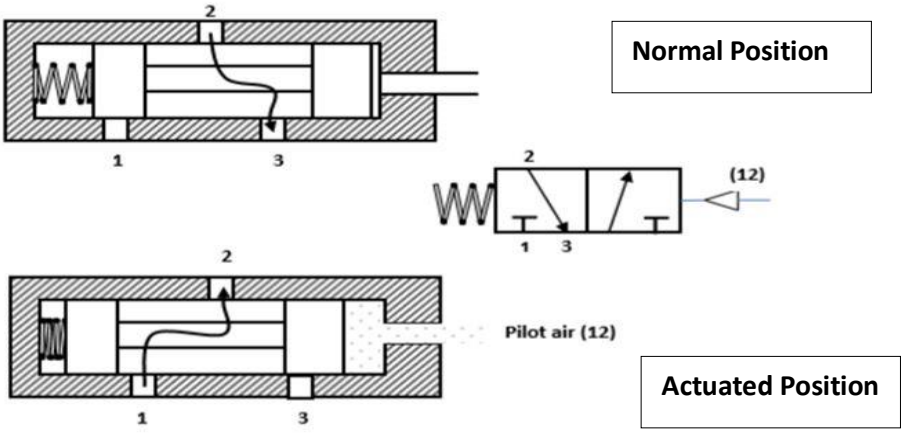
d) **A machine holds the steel sheet and then punches a hole. The sheet is released when the punch goes back. Suggest and draw the suitable circuit for this situation.** — 01 mark for circuit name; 03 marks circuit diagram

Suggested circuit : - Sequencing Circuit

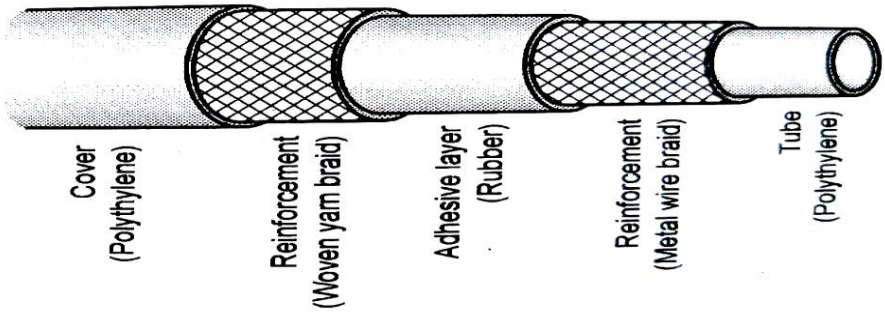
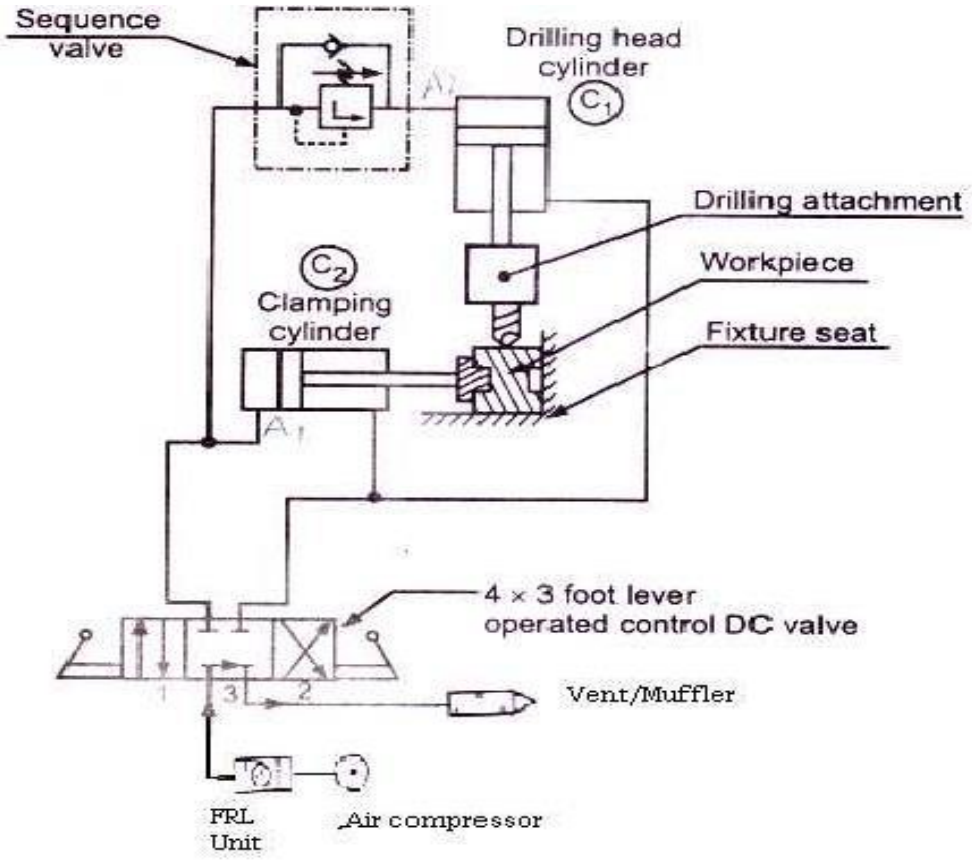


4 **Attempt any THREE of the following:** — 12

a) **Explain with neat sketch working 3/2 DCV.** — 02 + 02

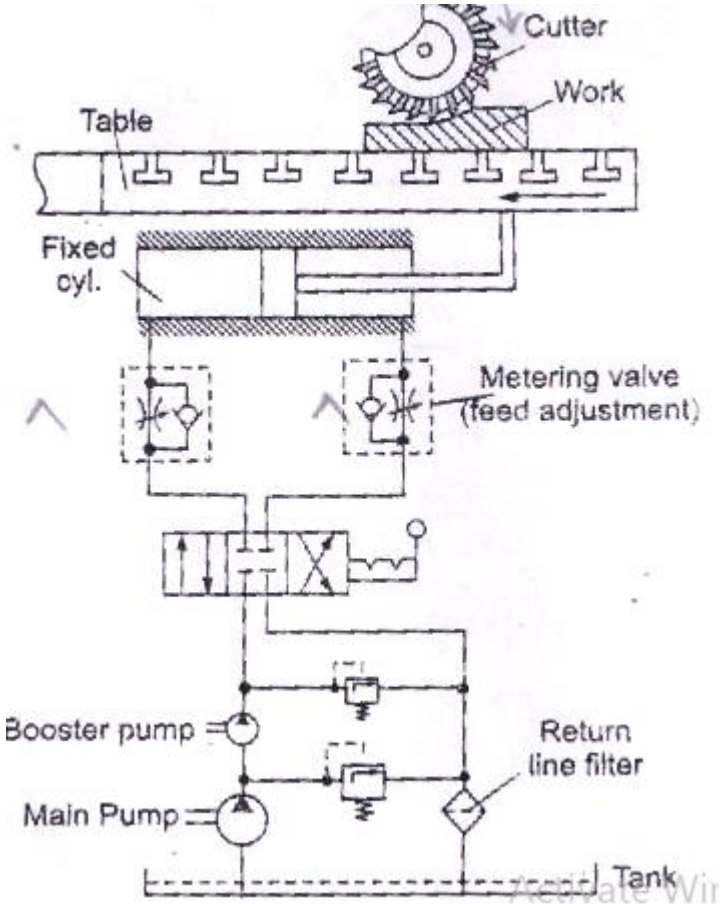


		Working:- Push button operated spring return type 3/2 sliding spool valve. It has spring loaded spool inside the valve body. In actuated position there is connection from port 1 to port 2,oil flows from pump to SA cylinder & hence SAC extends. In normal position there is connection from Port 2 to Port 3 ,Oil flows from SA cylinder to tank & SAC Retracts. Here inlet port 1 is closed.	
	b)	**Give Classification of control Valve.** 1) According to function. a) Pressure control Valve. i) Pressure relief valve. ii) Pressure reducing valve. iii) Unloading Valve. b) Direction control valve i) 2 x 2 DCV ii) 3 x 2 DCV iii) 4 x 2 DCV iv) 4 x 3 DCV c) Flow Control valve. i) Fixed displacement FCV ii) Variable displacement FCV iii) Pressure compensated FCV 2) According to method of actuation a) Manual operated i) Push button operated. ii) Hand lever operated. iii) Pedal operated. b) Pilot operated i) Single Pilot operated. ii) Double Pilot operated. 3) According to Construction. a) Poppet type. i) Ball type. ii) Conical Poppet type. b) Spool type i) Sliding spool type. ii) Rotary spool type.	Any 04 types (1 mark each)

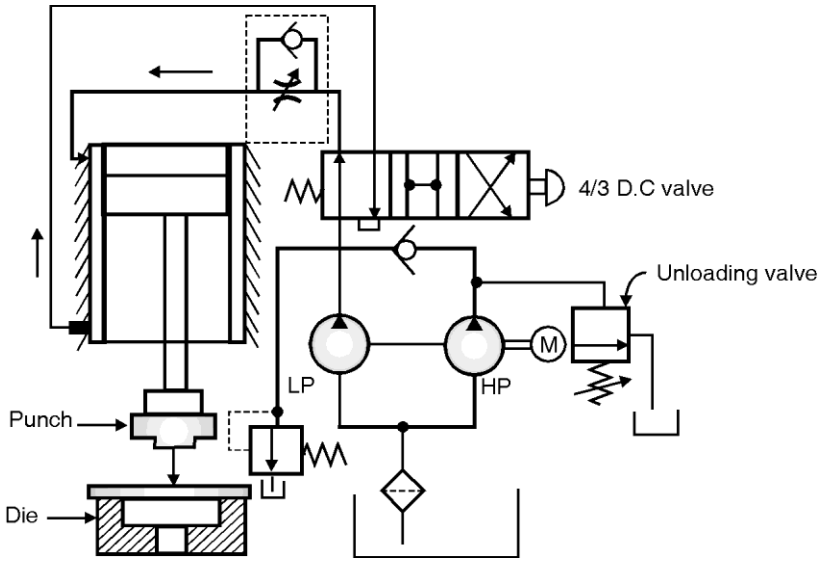
	c)	**Explain flexible hose. State its material and application**  **Explanation:-**Flexible hose pipes are extensively employed in hydraulic systems and pneumatic systems. As they are easy to accommodate and to connect with in the available space. These pipes are made of elastic material and can be bent easily. Flexible pipe is made of several layers with metal wire braiding between them. Those metal wire reinforcement increases the strength of the pipe **Material:-** Nylon braided hoses, Steel wire reinforced rubber hoses, poly-urethene tubes, poly-ethylene tubes. **Application**:-Convey the hydraulic oil. It is used to transfer liquids under high pressure in the oil industry.	01 mark 01 mark 01 mark 01 mark
	d)	**Pneumatic circuit using Sequence valve**  **Explanation :-** Pressure dependent sequencing circuit :	02 + 02

The circuit is used for drilling a hole in work piece.
The sequence operation is
a) Clamping of work piece
b) Drilling
c) Decamping and drill taken out from hole.
The DC valve takes centre position (no 3.) no compressed air supplied to either of cylinder C1 or C2. Now undrilled work piece is kept on fixture seat. The compressed air from compressor is going to vent via DC valve so no movement of cylinder C1 or C2.
Now compressed air start supplying directly to C2 and through sequence valve to C1
When compressed oil enters through port A2 of cylinder C2 piston will advance and immediately clamps the work piece.
At the same time compressed air flow towards port A1 of cylinder C1 but through the sequence valve.
Some higher pressure is set at pressure relief valve of sequence valve when the pressure of flowing air reaches this set value the sequence valve opens and air enters through port A1 into cylinder C1 due to this piston advances comes down so that drilling starts.
When operator again operate foot lever of DC valve it takes position 2 and both piston retracts and work piece de-clamps and drill comes out of drilled hole.

e) **Hydraulic circuit of milling machine & explain its working.** — 02 + 02



Explanation: - Hydraulic circuit for milling machine is comparatively different from other circuits. Table movement of milling machine is required to be adjustable for different feeds for different type of work. Therefore for both strokes of the cylinder, on both ends of cylinder flow control

		valves are used. Another feature of this circuit is that there are two pumps 1. Main pump – low pressure high discharge 2. Booster pump - high pressure low discharge The function of booster pump is to boost the hydraulic pressure to a higher level than given by main pump. Reason behind using this type is to save power as well as use of high pressure high discharge pump is avoided. 4/3 DCV used manually operated stroke length of cylinder is adjustable through limit switch. In centre position of 4/3 DCV all the ports are close therefore, total hydraulic system is lock. In position (I) pump flow is given to cylinder blank end and extension starts and oil from rod end is discharge to tank In (II) position, pump flow diverted to rod end for retraction and blank end side flow pass to tank.	
5		**Attempt any TWO of the following:**	12
	a)	**Draw and Explain two pump unloading circuit**  **Importance of circuit:** • High-low system of pump consists of two pumps in which one pump has high flow rate and other has low flow rate. They are used to save the system power. Both pumps can be used simultaneously depending upon system requirement or high flow rate is diverted through unloading valve if needed in the system. • It is useful when combination of rapid and slow movement required in the circuit. **Explanation of Circuit :** • The circuits has low pressure (LP) and high pressure (HP) pumps are provided as shown in Fig. • When rapid movement of the punch is required, both LP and HP supply the oil so that the piston retraction will be faster compared to advanced cutting stroke. • Initially slow movement is required when punch starts movement towards the workpiece, the flow of HP is diverted through unloading valve and only LP will supply the oil to the actuator. • When punch reaches near the workpiece, high force is needed for press	02 +04

operations, HP supply will be started to combine with LP and high pressure is generated for performing press operation.

Applications :

Hydraulic press machines.

b) **Two faults detected in Pneumatic circuit and its causes and remedies** — 1 mark each for fault, causes and remedies. Any two

1)Fault: No pressure in the pressure side.

Causes: Air leakage, pressure gauge faulty

Remedies: Check pressure gauge working properly and repair it.

2)Fault: Service unit (FRL) failed to work properly

Causes: Filter stopped**,** Pressure regulator reads differently, Absence of oil drops in lubricator

Remedies: Clean filter to remove clogging, Set regulator properly, Fill up oil container of lubricator

3) **Fault:** Operating trouble of compressor

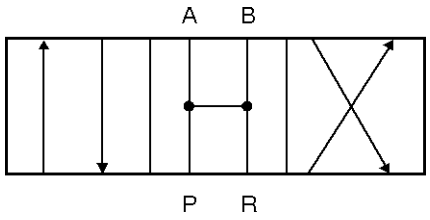
Causes: Dirt in suction filter, Worn out piston rings

Remedies: clean the filter, replace Worn out piston rings

c) **Situations in which following Centre positions of DC valves are used** — Each position 3 marks for explanation. With symbol

1) All ports open (Open centre position) :

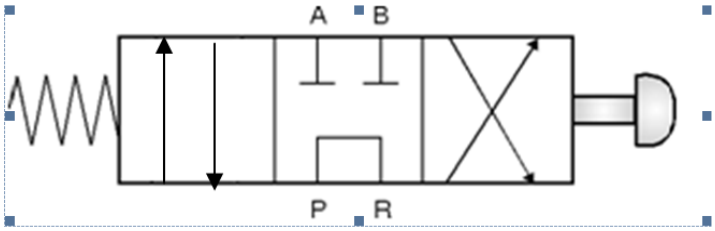
- In this position, all ports are connected internally. Here oil flows through all ports P, A, B and R.
- The open centre condition is used to unloads the pump and allows the actuator to stop or float.
- It causes little shock during changeover to other conditions of valve. Fixed volume pumps are used for this centre condition.

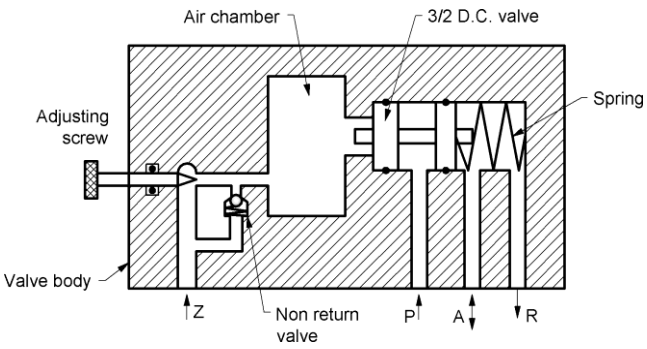


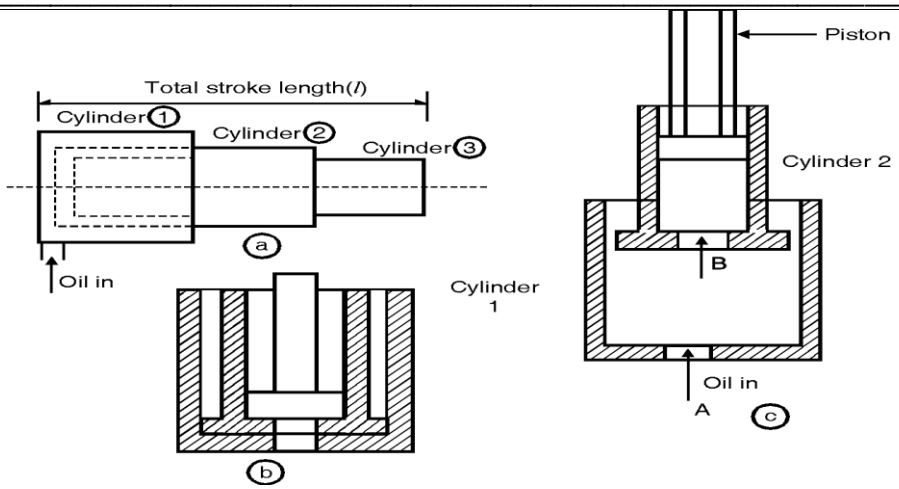
2) **Tandem Centre position :**

- This center is very common in applications like the simple press circuit, to allow the pump's flow to go straight to the tank, rather than forcing it over the relief valve.
- In this position, Port P of pump is connected to port R to divert flow of pump to the tank. Port A and B of actuator are closed.

- It will unload the pump to the reservoir while blocking the cylinder ports A and B. Fixed volume pumps are used for this centre condition.



6		**Attempt any TWO of the following:**	12
	a)	**Valve selection for delay the controlling action :** Time Delay valve is used for **delay the controlling action by sometime after the actuation od Dc valve.**  **Working:** • Initially when compressed air is supplied to the port P of the valve, it is prevented from flowing to port A from port P, as the spool blocks this port A. • When air is allowed to enter through pilot port Z, it flows through needle operated flow control valve where its flow can be regulated. • The air then enters in the air chamber where pressure starts building here. when sufficient amount of pressure is generated, it pushes the spool of 3/2 D.C. valve. • Now the opening port P is get connected port A and port R is closed. Air can flow easily from port P to port A to actuate the actuator. • The time required to build up the pressure in the reservoir is the amount of time delay of the time delay valve. The time delay can be set by using needle adjustment screw to control flow rate of air.	Selection : 2 marks Figure 2 marks Working 2 marks
	b)	**Selection of an actuator for longer stroke length:** • Telescopic cylinder is used for longer stroke length and can be accommodated in less space after retraction. • The cylinders are arranged in a short envelope hence space required is less.	Selection



: 2 marks

Figure 2 marks

Working 2 marks

Working :

- When pressurized oil enters in the main cylinder 1 it will push the cylinder 2 in the upward direction when sufficient oil pressure is generated.
- Now the cylinder 2 is completely lifted and oil will enter into the inlet of cylinder 2.
- The oil will flow in the cylinder 2 and push the piston in upward direction. It will raise the piston for stroke length of cylinder 2.
- In this manner, the total length of stroke through which the load is lifted is (L_1 + L_2).
- It is suitable where less space is available for mounting of actuator.
- Used in equipment like tilting of truck dump bodies, fork lift trucks, hydraulic cranes.

c)

Difference Between Hydraulic and Pneumatic system

Sr. No.	Point	Hydraulic	Pneumatic
1.	Medium used	Hydraulic system uses Oil	Pneumatic system uses Air
2.	Storage of medium	Reservoir is required to store oil	Air is free from atmosphere hence storage of input medium not required
3.	Storage device	Reservoir of suitable capacity in liters	Air receiver to store compressed air under pressure
4.	Reuse	Re circulated again to save cost	Freely available hence not necessary to recirculate.
5.	Cost of medium	Hydraulic oil is Costly	Freely available from nature. But cost of compression
6.	Power device	Pump is used to increase pressure of an oil	Compressor is used to increase pressure of an air
7.	Return lines	Required for recirculation	Not required direct exhausted to atmosphere
8.	Lubrication	Self lubricated as oil is	Separate lubricator needed for

Any 06 points (01 mark each)

					having lubrication characteristics.	smooth working of system	
			9	Operating pressure	300 to 700 bar	Limited to 10 bar	
			10	Application	Heavy equipments cranes, lifts, farm equipments, JCB bulldozer, etc	Hand tools, press machines, foundry machines, small cranes, etc	
		-------END----					

22655

12223

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answer with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Draw I.S. symbol for :–

i) $^{4}/_{3}$ D.C.V.

ii) Sequence valve.

b) Define :–

i) Viscosity

ii) Specific weight

c) State applications of Linear and Rotary actuator.

d) List various factors considering while selection of pump.

e) State the different functions of valves.

f) State the different types of filters used in fluid system.

g) State the common faults that can be observed in Pneumatic circuit.

P.T.O.

Marks

2. Attempt any THREE of the following: **12**

a) State the advantages and limitations of hydraulic and pneumatic systems.

b) Explain the working of Tandem cylinder with neat sketch.

c) Explain the working of check valve with neat sketch.

d) Explain with neat sketch working of any one rotary compressor.

3. Attempt any THREE of the following: **12**

a) Compare gear pump and vane pump on the basis of :–

i) Construction

ii) Speed

iii) Application

iv) Pressure.

b) Explain the working of sequence valve with neat sketch.

c) Compare between meter in and meter out circuit.

d) A machine holds the steel sheet and then punches a hole. The sheet is released when the punch goes back. Suggest and draw the suitable circuit for this situation.

4. Attempt any THREE of the following: **12**

a) Explain with neat sketch working of $^{3}/_{2}$ DCV.

b) Give the classification of control valves.

c) Explain flexible hose. State its material and application.

d) Construct Pneumatic circuit using sequence valve to control two applications performed in a proper sequence and describe its working.

e) Draw the neat labelled hydraulic circuit of milling machine and explain its working.

Marks

5. Attempt any TWO of the following: **12**

a) Draw and explain two pump unloading circuit.

b) Mention any two faults detected in pneumatic circuit and give its causes and remedies.

c) Discuss the situations in which following type of centre position of DC valves are preferred :–

i) All ports open

ii) Tandem centre.

6. Attempt any TWO of the following: **12**

a) It is required to delay the controlling action by some time after the actuation of DC valve. Select the suitable valve for this application and explain its working with neat sketch.

b) One application needs a single acting cylinder capable of giving longer stroke strength. However, the space available to fit in that cylinder in retracted condition is comparatively less. Suggest the type of actuator to be used in such condition with justification. Explain its working with sketch.

c) Differentiate between Hydraulic and Pneumatic system. (Minimum six points.)

WINTER – 2022 EXAMINATION

Model Answer

Subject Name: **Automobile Engineering.** **Subject Code:** **22656**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following: (2 x 5)**	10
	a Ans.	**Compare front engine front wheel drive (FEFWD) with front engine rear wheel drive (FERWD) (Any Four Points).** **Comparisons between FEFWD V_s FERWD:**	02 **Any four Points, 1/2 M for each)**

S.N.	Front Engine Front Wheel Drive	Front Engine Rear Wheel Drive
1	Engine is mounted in front of the front axle, and the drive is also given to the front axle for driving the front wheels.	Engine is mounted at the front and the power is transmitted from the engine to the differential , rear axle via the propeller shaft.
2	More weight distribution at forward.	Balanced (Even) weight distribution
3	No need for a Propeller shaft for power flow.	Need of Propeller shaft for power flow.
4	No speed limitations due to the absence of a propeller shaft.	Speed limitations due to whirling of the propeller shaft.
5	Increased interior space.	Decreased interior space.
6	Lower center of gravity.	Higher center of gravity.
7	Ground clearance is less.	Ground clearance is more.
8	Improved fuel efficiency due to less weight.	Less fuel efficient compared to Front Engine Front Wheel Drive.
9	Lower initial cost.	Higher initial cost.

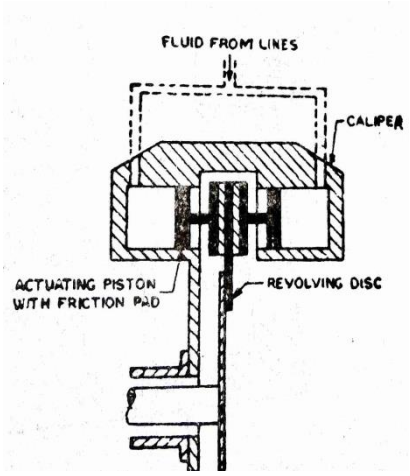
	10	**Applications:** TATA Indica, Maruti 800, Maruti Omni, Matador	**Applications:** Ambassador, Fiat, Truck & Buses	

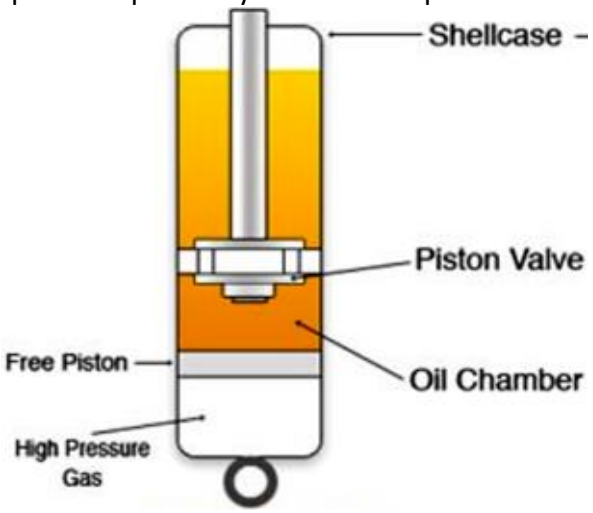
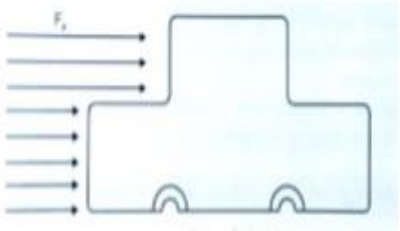
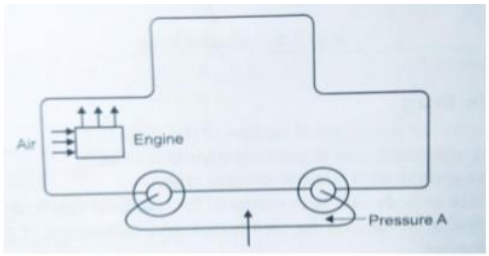
b Ans.	**State working principle of a centrifugal clutch.** **Working Principle of Centrifugal Clutch:** The centrifugal clutch operates on a **principle of centrifugal force**, instead of spring force for keeping it in the engaged position. The force acting away from the center; is known as a Centrifugal force. Centrifugal clutch does not require a clutch pedal for operation. The clutch is operated automatically depending on the engine speed. The vehicle can be stopped in gear without stalling the engine. Similarly, the vehicle can be started in any gear by pressing the accelerator pedal. This makes the driving operation very easy.	**2 M for appropriate principle statement**
C Ans	**Define under steering and over steering.** During turns, *centrifugal force* acts on the wheels. Two cases can arise; ***(i) Under steering (ii) Oversteering.*** These two conditions are equally valid even when the vehicle is going straight and is subjected to *side force* due to *road camber* or some *crosswind*. **Under Steering:** The vehicle will try to move away from its normal direction of motion & therefore to keep it on the right path, the driver shall have to steer a little more than is theoretically needed. This condition is known as **Understeer**. **Over Steering:** The vehicle will try to move in its normal direction of motion & therefore to keep it on the right path, the driver shall have to steer a little less than is theoretically needed. This condition is known as **Oversteer.**	**01** **01**
d Ans	**List components of a vehicle counted in sprung and un-sprung weight.** **Components of vehicle counted in Sprung weight:** It is the weight supported by the spring. (Anything carried by the weight of springs.), which includes; ***the weight of the frame, body, engine, and entire transmission system.*** **Components of vehicle counted in Unsprung weight:** It is the weight of other parts of the vehicle which is not supported by springs, *including; the* ***weight of the rear axle assembly, steering knuckle, front axle, wheels, tires, and brakes.***	**01** **01**
e Ans	**Write the principle of working of Lead acid battery.** **Principle of Working of Lead Acid Battery:** It operates on the ***principle of Electrolysis***. Electrolysis is the conduction of electricity between two electrodes immersed in a solution containing ions (electrolytes), which causes chemical changes at the electrodes. When two dissimilar metal plates for example one copper and one zinc, were immersed in an acid solution and joined by a	**02**

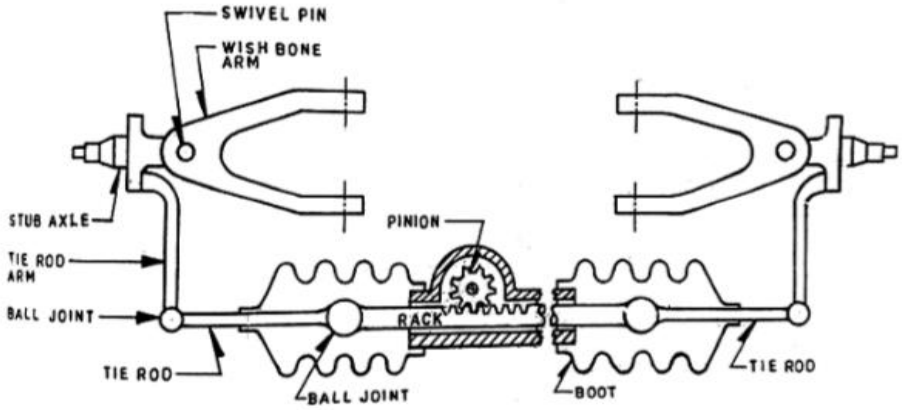
		wire a small current flowed through the circuit. This basic principle is used in Lead acid batteries with active materials used as lead peroxide (P_bO_2) on a positive plate and spongy lead (P_b) on a negative plate along with a combination of distilled water and sulphuric acid (H_2SO_4) as an electrolyte. **P_bO_2 + $2H_2SO_4$ + P_b** **[+ve Plate] [Electrolyte] [-ve Plate] ==== (Charge condition)** **P_bSO_4 + $2H_2O$ + P_bSO_4** **[+ve Plate] [Electrolyte] [-ve Plate] ==== (Discharge condition)** **(2 Marks for an appropriate explanation of the principle of electrolysis/Chemical reaction of lead acid battery)**	
	f Ans	**Define HGV and MGV.** **Heavy Goods Vehicle (HGV):** HGV means any goods carriage with the gross vehicle weight of which or a tractor or a road roller the unladen weight of either of which, exceeds 12,000 kg. **Medium Goods Vehicle (MGV):** MGV means any goods carriage other than a light motor vehicle or a heavy goods vehicle.	**01** **01**
	g Ans	**State need of universal joint and slip joint used in the propeller shaft.** **Need of Universal Joint and Slip Joint in propeller shaft:** **Need for Universal Joint:** A universal joint is a particular type of connection between two shafts, whose axes are inclined to each other. It is used where two shafts are connected at an angle to transmit the torque. The purpose of the universal joint in an automobile is to absorb the angular changes brought about by changes in relative positions of the differential in relation to the transmission and in this way to smoothly transmit power from the transmission to the differential. U joints take care of the variation in the inclination of the propeller shaft during the up-and-down movement of the vehicle. **Need of Slip (Sliding) Joint:** Depending upon the type of drive, one slip joint may be there in the shaft. This serves to adjust the length of the propeller shaft when demanded by the rear axle movements. Slip joint used to accommodate the change in length due to road irregularities.	**01** **01**

2		**Attempt any <u>THREE</u> of the following: (3 x 4)**	**12**
	a	**List different frames used in automobile construction. Write functions of the frame.**	
	Ans	**Types of Frames used in Automobiles:** (A) **According to Construction:** (i) Conventional frame (ii) Integral Frame (Unitized Body/Frameless construction/Monocoque construction) (iii) Sub/Half Integral frame **(B) According to Engine Position:** (i) Full Forward Chassis Frame (ii) Semi Forward Chassis Frame (iii) Bus Chassis Frame	**02**
		Functions of Frame: [1] To support the chassis components and the body. [2] To withstand static and dynamic loads. [3] To carry the weight of the vehicle and its passengers. [4] To withstand the centrifugal force while cornering. [5] To propel the vehicle directs its motion. [6] To maintain the space and relationship between the other parts. **(Any two appropriate types of Chassis Frame: 1 M each, Any two appropriate functions of Chassis frame: 1 M each)**	**02**
	b	**List various parts of the synchromesh gear box with the role of each component.**	**Appropriate name of any four components along with function/role , 1 M for each**
	Ans		

S. No.	Name of Component	Role/Function of Component
1	Clutch (Engine Shaft)	Connected to the flywheel as the input shaft.
2	Gears on Main (Splined) Shaft	Gears on the main shafts are free and always in mesh with corresponding gears on the countershaft.
3	Free Members	Free members are free to slide on splines on the main shaft.
4	Ring Shaped Member	Ring-shaped members having internal teeth fit onto the external teeth members.
5	Dog Teeth on Gear B & Gear D	Dog teeth fit onto the teeth of ring-shaped members.
6	Forks	Used to select appropriate gear as per requirement.
7	Spring Loaded Balls	Tend to prevent the sliding of ring-shaped members on free members.
8	Frictional Surfaces	Frictional surfaces are slightly attached and meshed with the respective conical faces of gears after synchronizing the speed as per gear requirement.
9	Gears on Counter Shaft	Always fixed on the countershaft and meshed with the gears on the main shaft.
10	Reverse Gear on Reverse Shaft	To make reverse position arrangement.

	C	**Describe the working of the Disc brake. Draw a net sketch.** **Working of Disc Brake:** Motor vehicles are now fitted with disc brakes instead of conventional drum brakes. Disc brakes use friction to create braking power. Disc brakes create braking power by forcing flat friction pads against the sides of the rotating disc. Disc brake mainly consists of, (i) Rotor (ii) Caliper, and (iii) Brake pads. In between each piston & disc, a friction pad is held in position by springs. When the brakes are applied, hydraulically actuated pistons move the friction pads into contact with the discs, applying equal and opposite forces on the latter. On releasing the brakes, the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc.  **Figure: Disc Brake**	**02 M for appropriate working of disc brake, 02 M for neat labeled sketch**
	d Ans	**Explain the working of gas-filled shock absorbers in brief. Draw a simple sketch for the same** **Gas-Filled Shock Absorber:** The gas-filled shock absorber is a hydraulic shock absorber that is *charged with gas*. The principal gas used in *nitrogen* is kept under either; *Low pressure (10-15 Kg/cm2) or High pressure (20-30 Kg/cm2).* **Working of Gas-Filled Shock Absorber during Bounding *(Compression)*:** The piston rod moves downward, causing the pressure of the fluid to be higher in the lower chamber than in the upper chamber. Therefore, the fluid in the lower chamber is forced into the upper chamber through the piston valve. At this time, the damping force is generated by the flow resistance of the valve. The high-pressure gas exerts great pressure on the fluid in the lower chamber, forcing it to flow quickly & smoothly into the upper chamber. This ensures a stable damping force. **Working of Gas Filled Shock Absorber during Rebounding *(Expansion)*:** The piston rod moves upward causing the fluid pressure in the upper chamber to be higher than that in the lower chamber. Therefore, the fluid in the upper chamber is forced into the lower chamber through the piston valve and the resistance exerted by the valve acts as a damping force. Since the rod moves upward, a portion of it moves	**02 M for the appropriate working of Gas Filled Shock Absorber, 02 M for suitably labeled sketch**

		out of the cylinder, so the volume of fluid displaced by it decreases. To compensate for this, the free piston is pushed upward by a distance equivalent to this volume.  **Figure: Monotube Type Gas Filled Shock Absorber**	
3		**Attempt any <u>THREE</u> of the following (3 x 4)**	12
	a	**Explain the following terms related with car Aerodynamics. (i) Drag (ii) Lift** **(i) Drag:** It is the largest and most important aerodynamic force encountered by a vehicle at normal highway speeds. The major factors included in aerodynamic drag are- Induced drag, profile drag, and Friction drag. It depends on the shape of the body. Air drag is given by the equation, $D_A = ½ \rho V^2 C_D A$ Where, ρ= Density of air V= Speed of Vehicle CD = Coefficient of Drag A= Frontal Area of the vehicle.  Figure Aerodynamic Drag **ii) Lift:** The pressure difference from the top to bottom of the vehicle causes the lift force. The lift force is measured at the centerline of the vehicle at the center of the wheelbase. The aerodynamic lift and pitching moment are undesirable effects. The lift force is given by the equation, $L_A = ½ \rho V^2 C_L A$ Where, ρ= Density of air V= Total wind velocity CL = Lift Coefficient A= Frontal Area of the vehicle.  Figure aerodynamic lift	**Appropriate significance of Drag and Lift, 02 M, 02 M for suitable sketch of Drag & Lift**

	b Ans	**Explain Rack and Pinion type steering gearbox with a neat sketch.** **Rack and Pinion Type Steering Gear Box:** In this type of steering gearbox, a pinion is mounted at the end of the steering shaft. The pinion engages with the rack which is provided with a ball joint at each end in order to allow for the rise and fall of the wheel. The rotary motion of the steering wheel is transmitted to the pinion. The circular motion of the pinion is converted into the linear rack movement, which is further transmitted to tie rods to the stub axle through the ball joint. This type of steering gearbox provides sufficiently low gear reduction for cars and it is quite suitable even for heavier motor vehicles if assisted with power. It occupies very less space and less a number of linkages.  Figure: Rack and Pinion steering gear	**2 M for explanation, 2 Marks for neat labelled sketch.**
	C Ans	**State function and need of independent suspension system.** **Function of Independent Suspension System:** 1. It has light moving parts that help the wheel to follow the road irregularities. 2. The Unsprung weight is low. 3. It absorbs road shocks or impacts due to bumping in the road by oscillation. 4. Tires also provide a spring effect, but to a smaller extent. 5. It set the parameters like camber, caster, and kingpin inclination for better steering Quality. 6. Axle should not tilt and the wheel remains vertical. 7. It reduces the shocks to passengers and gives a comfortable ride, also reducing additional stresses in the automobile frame body. 8. It requires a more rigid subframe or chassis frame. **Need for Independent Suspension System:** 1. In order to provide a comfortable ride to the passenger and avoid additional stresses in the vehicle frame. 2. The vehicle should neither bounce nor roll or sway the passengers when cornering nor pitch when accelerating, braking or suddenly lifting or dropping of the front wheel with respect to the rear wheel. 3. Although some of the road irregularities and inequalities are absorbed by large tires. 4. It may provide a softer suspension because the low spring rate (stiffness) enables	**Any 4 appropriate points in Function, ½ M each, Any 4 appropriate points in Need, ½ of each**

large wheel movement.
5. In this the engine and chassis frame can be placed relatively lower which means the engine position can be moved forward so more space for the passenger.
6. The unsprung weight is low.

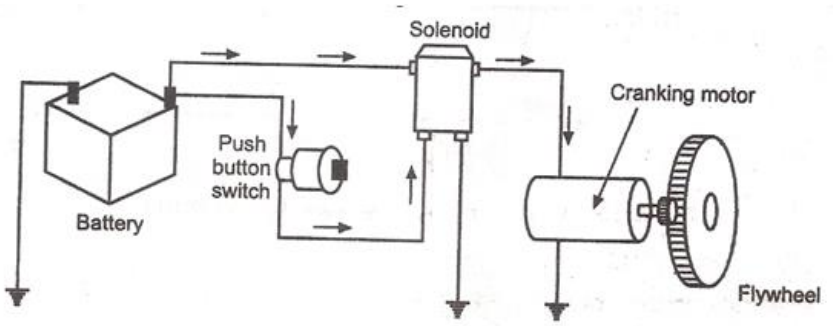
d

Ans

Explain the working of starting system of a vehicle with a neat sketch.

Working of Vehicle Starting System:

The starting or cranking system consists of starting motor, battery, control switch, and interconnecting wiring. The starting system is the heart of the electrical system in automobiles. The key is inserted into the ignition switch and turned to the start position a small number of current passes through the neutral safety switch to the starter relay or starter solenoid. The Starter solenoid allows high current to flow through the battery cable to the starter motor. The starter motor cranks the engine so that the piston moving downward, can create suction that draws the air-fuel mixture into the cylinder.



Starting system

2 M for Working, 2 M for suitable sketch/block diagram

4

Attempt any THREE of the following: (3 x 4)

12

a

Ans

Explain the necessity and importance of Cable Color Codes in automobiles.

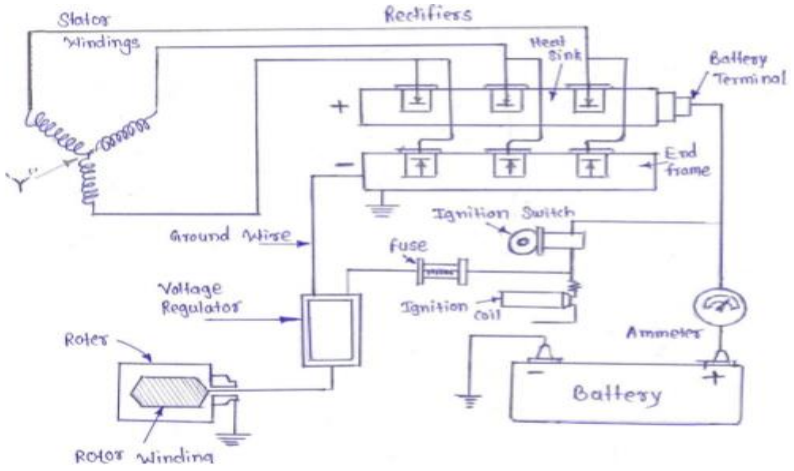
Necessity and Importance of Automobile Cable Color Codes:

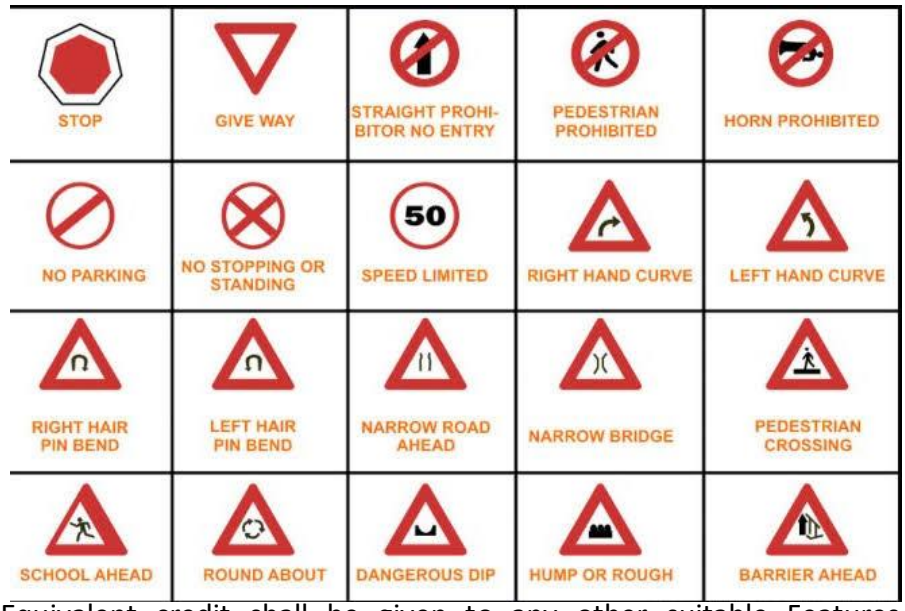
In order to quickly identify and also to simplify the wiring system, the cables are colored. For quick identification, insulations of various wires in a circuit are assigned different colors. The seven-color code system is the general one and involves brown, yellow, red, white, green, blue, and black colors. In motor vehicle wiring systems there are a number of wires for different systems such as a headlamp, fog, side indicator, horn, etc. As the wires are more for each circuit, we have limited space for making a suitable arrangement of wiring.Thus, the following seven color code systems mentioned below, used in an automobile:

Color codes

Sr. No	Colour	Colour code	Function
01	Brown	BR	Battery circuit
02	yellow	Y	Generator circuit
03	White	W	Ignition circuit
04	Green	G	Auxiliary circuit
05	Blue	BL	Head lamp circuit
06	Red	R	side lamp and tail lamp
07.	**Black**	**B**	**For grounding.**

2 M for appropriate statements of need and importance, 2 M for examples of color coding

	b Ans	**Explain the charging system of a vehicle with a neat sketch.** **Automobile Charging System:** (a) The battery is the storage of direct current. The battery has to supply the current to the starter at the time of starting as well as to the various accessories of the automobile. Due to prolonged use, the charge of the battery is decreased. Therefore to keep the battery always in charged condition there is a need for a charging system. (b) The charging system consists of an alternator provided with a rectifier to convert AC to DC and a voltage regulator to limit the generator voltage to a correct value. The alternator consists of a stator, Rotor which is driven by a fan belt. (c) When the Ignition switch is turned on, the rotor receives the current from the battery through the voltage regulator. This current energizes the rotor field magnet, which induces a current in the stator windings as the rotor is turned by the pulley. The induced alternating current is changed to a direct current by the rectifier.  	**2 M for the appropriate significance of charging system, 2 M for neat labeled sketch/block diagram**
	c Ans	**Write silent features of the motor vehicle Act 1989. Draw any 04 traffic signs and state their meaning.** **Salient Features of M. V Act 1989:** ● This act covers the following point: Offenses and Penalties, Documentation, Control of traffic, Construction and maintenance of Vehicle. ● The policy must be against any liability incurred by the insured in respect of death or bodily injury to any person or damage to any property of a third party. ● The insurer can be made a party to the proceedings of the Motor Accident Claims Tribunal. ● Background: Currently, as per the Central Motor Vehicle Rules, 1989, a transport vehicle driver must need to have passed Class VIII. ● It will also help meet the shortage of nearly 22 lakh drivers in the country's transport and logistics sector, which is hindering economic growth. ● This act emphasized that anyone applying for a driving license will have to mandatory pass a stringent skill test ● Since driving schools are subject to regulatory control by states, therefore, training imparted should be of high quality and must cover all aspects of driving a particular type of motor vehicle	**2 M for Salient Features of M V Act, Any 4 Traffic signs in the category of Mandatory, Cautionary, and Informatory, ½ M each**



Note: Equivalent credit shall be given to any other suitable Features and signs produced by students.

d

Ans

Enlist any four gauges and sensors with their functions.

Gauges with their Functions:

[1] Fuel Gauge: To indicate the level of fuel in the fuel tank.
[2] Water temperature Gauge: To indicate the temperature of engine cooling water.
[3] Oil Pressure Gauge: To indicate the oil pressure in the engine.
[4] Speedometer: Use to measure the speed of the automobile vehicle.
[5] Tachometer: Use to Measure the RPM of the Engine.

Sensors with their Functions:

[1] Mass airflow Sensor: Use to calculate the air density in the engine.
[2] Engine Speed Sensor: Use to monitor the crankshaft rotation speed.
[3] Oxygen Sensor: Use to monitor the content of exhaust gases.
[4] Coolant Sensor: Use to check temp. of coolant.
[5] Voltage Sensor: Use to manage the car idling speed.

Note: Equivalent credit shall be given to any other appropriate Gauges & Sensors enlisted.

Any 4 gauges with their function, ½ M each, Any 4 Sensors with their function, ½ M each

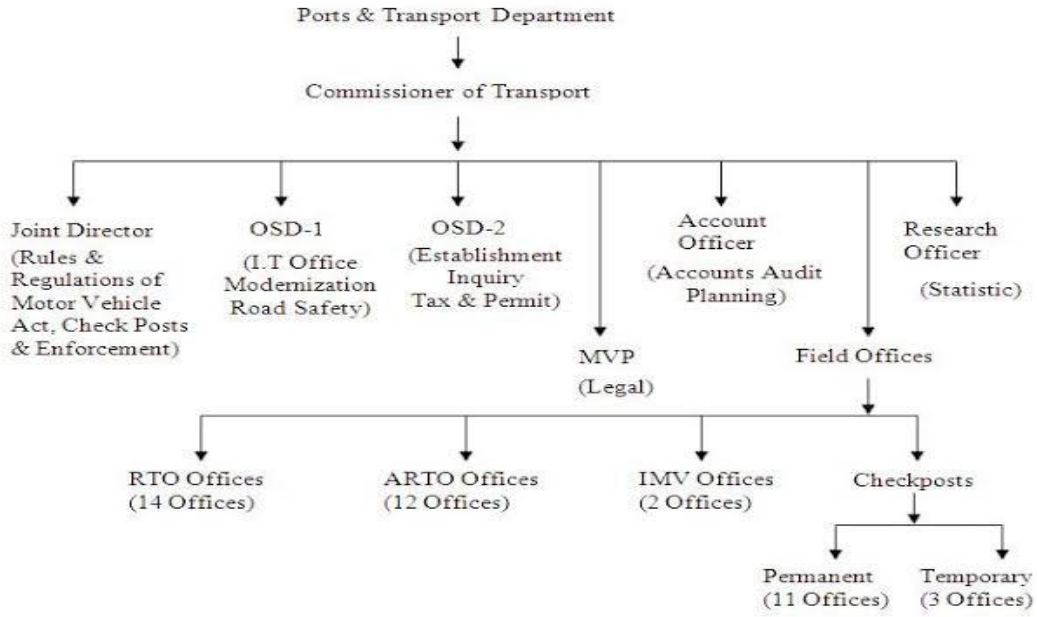
e

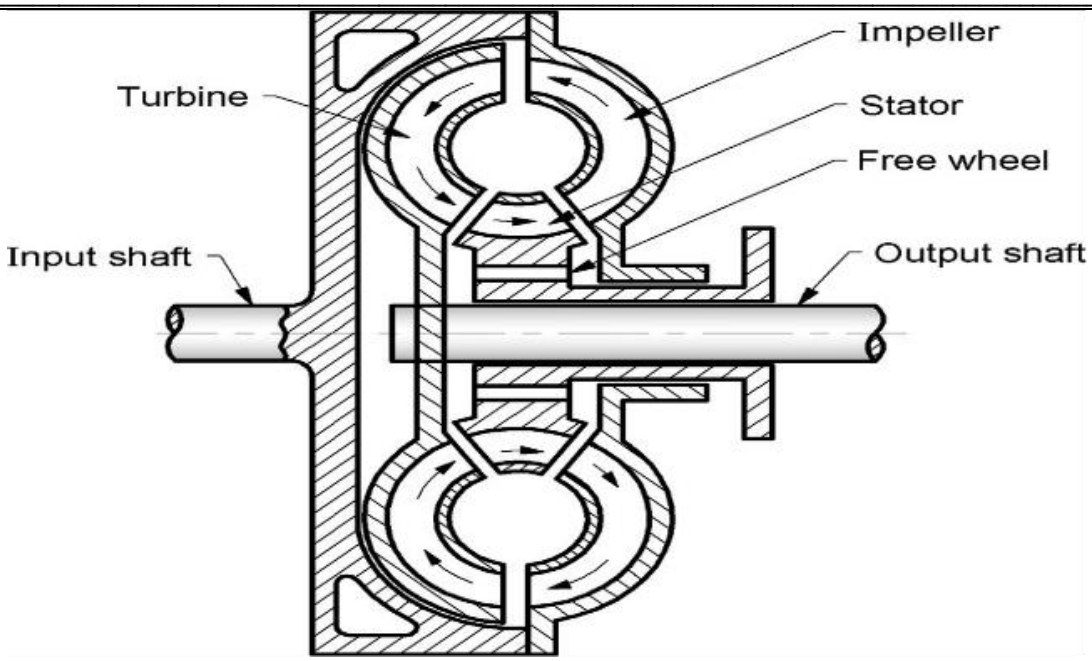
Ans

Draw the organization structure of the motor vehicle (RTO) department. Write the role of RTO.

Role of RTO:

1. To maintain a database of registered vehicles.
2. Mechanical inspection of accidental vehicles.
3. To grant a certificate of fitness to transport vehicles.
4. To issue International driving permits.
5. To routinely inspect vehicles.
6. Checking emissions and issuing pollution certificates for vehicles.
7. To conduct the driving test, issue Learner's, Permanent driver's licenses and

		renew the same. 8. To maintain a proper check on the validity of insurance on motor vehicles. 9. To issue badges to the drivers of public services vehicles like Auto rickshaws and Taxis.  	**2 M for suitable sketch of Organization structure, 2 M for appropriate role of RTO**
5		**Attempt any <u>TWO</u> of the following: (2 x 6)**	12
	a Ans	**Describe the torque converter with a neat sketch. Compare it with a fluid flywheel.** **Torque Converter:** The cut section of the torque converter as shown in Fig. Torque converter is a device that performs the same function as that of the gearbox. It transfers the torque by using fluid which acts as the connecting link. It is directly coupled to the engine flywheel. It increases torque in the ratio of 2: 1 to 4: 1. Generally, good quality engine oil is used as the fluid.	Discription - 02 M



Sketch 02 M

Figure: Torque Converter

Working of Torque Converter:

(a) When the engine is started, the impeller starts rotating. Due to centrifugal force at the impeller, its vane pushes oil into the turbine. This high-velocity jet of oil strikes the turbine vanes and forces it to rotate the turbine. As engine speed increases, this force also increases. When sufficient force is developed the turbine starts rotating and the vehicle move.

(b) The turbine vane angle is such that it changes the direction of oil flow so that it comes out of the turbine at the center; its direction is effectively backward. A stator is used to provide proper direction for oil to strike back on the impeller blades in a favorable direction. So, it avoids dragging action and prevents power loss.

(c) This flow of oil from the impeller to the turbine to the stator and back to the impeller goes continuously and the phenomenon associated is called torque multiplication. The maximum torque multiplication occurs when the turbine is stationary and the impeller is running fast at the engine speed this is called 'STALL'. The maximum torque multiplication at the stall is about 2.1 to 2.6 and goes on decreasing as engine speed increases.

(d) Torque multiplication will become unity when the impeller and turbine speed become equal this is known as direct speed.

Advantages of Torque Converter:

- [Simple in design.
- Less maintenance.
- No skill needed to operate.
- No frequent calibration is required.
- Smooth transfer of drive without any shock/jerk.
- No wear of moving parts because of no meshing gears.

- It is more economical than fluid flywheel at low speed.

.

Comparision between Torque Converter and Fluid Flywheel Converter

Fluid Flywheel	Torque Converter
Stator is absent	Stator is Present
It transmite the same torque as given as to it by engine shaft	It transmit more torque in the ratio 2:1 or 3:1
It merely acts as Hydraulic Coupling.	It serves the same purpose as that of the gearbox.

Comparision - 02 M

b

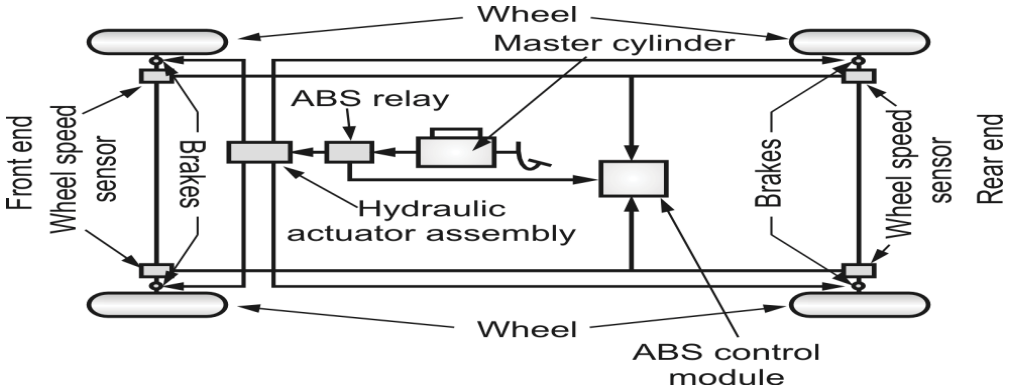
Ans

State need of ABS .Draw typical layout of ABS. Write in Brief role different components

Need of ABS

It is also known as anti-skid braking system. Wheels skid when they slow down faster than the vehicle.To prevent skidding of the vehicle the wheels must not be lock up. This is the purpose of antilock braking system.

Layout of ABS:-



1.5 M for the need of ABS,

1.5 M for Layout of ABS,

Role of Different Components:-

1. Electronic Control Unit (ECU)

It is heart of ABS.

It monitors and controls antilock brake function when required.

Its function based on input from wheel speed sensors and hydraulic unit to decide whether antilock operation is necessary or not.

		2. Accumulator It is used to maintain high pressure in braking system by storing hydraulic fluid. It also provides residual pressure for power assisted braking. **3. Wheel Speed Sensor** It is mounted on each wheel. It is used to measure speed of wheel. It sends signal to ECU. **4. Hydraulic Unit** The brake lines from the master cylinder are connected to it. It modulates the brake pressure as per the signals provided by the ECU.	**Role of any 2 major components of ABS in brief, 1.5 M each**
	C Ans	**List Factor affecting tyre life. State the meaning of all terms involved in following tyre Designation: P215/65R16 95 H.** **Factors affecting Tire Life:** **[1] Inflation Pressure:** The tyre must be run on specified air pressure given by the manufacturer. If tyre inflated with less pressure i.e. Under Inflated Pressure it will result in : (i) More flexing (ii)Uneven tread wear (iii)More tyre wear on sides (iv) Cracking of the side wall (v) Lack of directional stability (vi) Increased rolling resistance. (vii) If tyre is inflated with more tyre pressure i.e. Over Inflated Pressure it will result in; (viii)Reduces the road grip (ix) Less cushioning effect (x) Reduce the tread contact area (xi) More wear in the center of the tread **[2] Wheel Alignment:** Due to improper wheel alignment rapid wear of tyre thread takes place. Unequal camber results in excessive wear of tyre by pulling the wheels to one side. Too little or too much castor causes the wheel to wander resulting in spotty wear. If wheel balancing is not proper uneven load will occur on tyres, again radial and lateral run-out will also cause wear of the tyres. Badly adjusted brakes result in faster tyre wear in spots. The brake heat may also cause the failure of the tube and valve. **[3] Overloading:**	**Any 03 factors 01 mark each**

		In case of overloading the tyre has an insufficient amount of air to support the dead weight carried. This results in a decrease in tyre mileage. **[4] Driving manners:** This includes sudden acceleration, high speeds, sudden braking, driving on bad roads, etc. all cause faster tread wear. **5. Miscellaneous Factors-** These includes; **Heat:** Faster thread wear, radial side wall cracking, etc. may occur due to high temperature. **Road conditions:** On poor-quality roads tyre life decreases. Season (Weather condition): In winter the mileage is more and heat failure is less as compared to the summer season. **Position of tire:** Front tyres generally wear slower than rear ones. **Meaning of Tyre Designation: P215/65R16 95 H** The meaning of each marking is explained below; The first marking indicates the application/type of tire; **P-** P - Passenger Cars, C - Commercial Vehicle, LT - Light truck, T - Temporary (spare), ML - mining and logging, ST - special trailer, TR - truck. **215**: Second marking indicate the section width in mm of an inflated tyre. **215/65**: The third part indicates i. e. figure after the slash (/) aspect ratio of tire. Aspect Ratio = Section Height/ Section Width **R**- Fourth part indicate the construction type	**Tyre Designatio 03 marks**
6		**Attempt any TWO of the following. (2 x 6)**	12
	a Ans	**State the significance of the Live & Dead axle. Describe Semi Floating axle with sketch.** **Significance of live and dead Axle:** (a) It facilitates steering to turn the vehicle right or left as required. (b) It provides space for attachment of the suspension system, wheels, etc. (c) It prevents interference due to front engine location. (d) A live front axle contains the differential mechanism through which the engine power flows toward the front wheels. (e) It also acts as an anchorage for pivoting the stub axle. (f) Dead axle does not rotate and has no function to transmit power to road wheels. **Semi Floating axle:** The arrangement of the semi-floating axle is shown in Fig. It is also called as the half-floating rear axle. The driving wheel is directly bolted to the axle shaft at its outer end. The inner end of the axle shaft is splined and is supported by the differential unit. It has a single ball bearing which is mounted on the axle shaft and inside the axle casing.	**2 M for Significance of Live and Dead Axle, Brief description of Semi Floating axle, 2M, Neat Labelled sketch, 2 M**

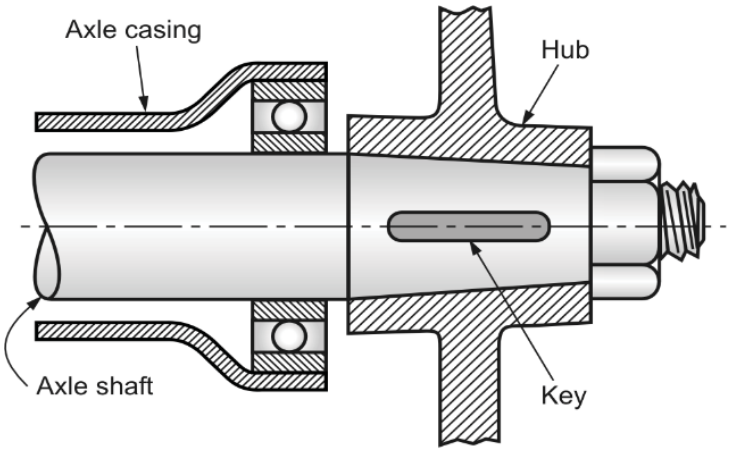


Figure: Semi Floating Rear Axle

Working of Semi Floating Axle:
The vehicle load is received by each of the half shafts through casing and bearing. This causes a bending load and tendency to shear at marked point P. The axle shafts also have to take end thrust and torque loads caused by the skidding, turning, and wobbling of the wheels.

Advantages of Semi Floating Axle:
[1] Simple design.
[2] Low cost.

Limitation:
[1] As the axle shafts have to carry all loads, they have to be of larger diameter for the same torque transmission as compared to the other two types' arrangements.
[2] Difficult to tow the vehicle if the half shaft is broken.

Application of Semi Floating Axle: Mostly used in cars and light-duty vehicles.

b

Draw an Electronic ignition system. Compare it with a Conventional ignition system (Any four points)

Ans

Electronic ignition system

- Electronic ignition systems use some solid state devices like transistors and capacitors, etc. to generate the right sparking voltage at right time.
- These systems have overcome the limitations of conventional (battery ignition and magneto-ignition) ignition systems. Modern automobiles make use of these systems. Two systems, common in use, are:
    a. Capacitive discharge ignition and
    b. Transistorized coil ignition.
- These systems are more reliable and require less maintenance. Wear and tear of components are reduced the and life of spark plugs is increased with the use of electronic ignition.

Note- Consider any One Diagram

01

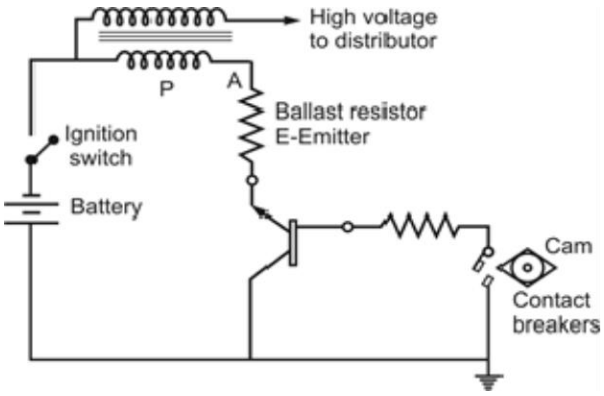


Diagram –Transistorized coil ignition

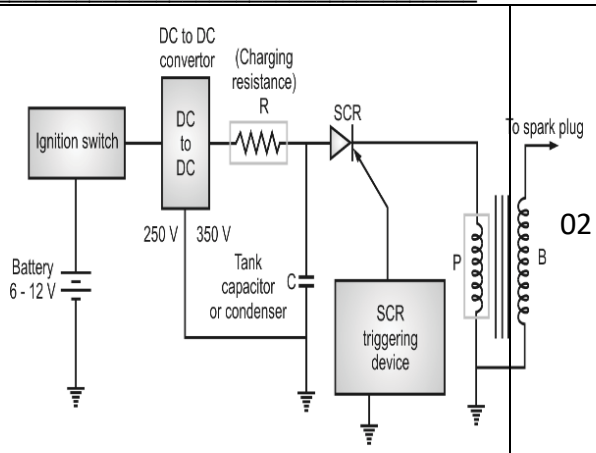


Diagram -Capacitive discharge Ignition system-

02

Compare it with a Conventional ignition system (Any four points)

a. Because of arcing, pitting of contact breaker point and which will lead to regular maintenance problems.
b. Poor starting: After a few thousand kilometers of running, the timing becomes inaccurate, which results in poor starting (Starting trouble).
c. At very high engine speeds, performance is poor because of the inertia effects of the moving parts in the system.
d. Sometimes it is not possible to produce spark properly in fouled spark plugs.

03

c

Describe in brief different passenger safety systems adapted in Modern Vehicles

Ans

Passenger Comfort and Safety Systems:

[1] Air Bags:

Airbags are passive safety features designed. Airbags are strong fabric bags that are folded and concealed behind various parts inside the vehicle. Many vehicles have a driver airbag in the steering column and a front-passenger airbag in the dashboard. Newer vehicles may also have side airbags located in the interior side panels, the roof, or the doors.

Any six systems 01 mark each.

Features of Air Bags:

It provides added protection to seatbelts. It reduces injury by either cushioning the occupant's contact with the interior of the vehicle or preventing contact completely in the event of a crash.

It inflates and deflates very rapidly in the event of a severe crash.

[2] Seat Belts:

Seatbelts are a passive vehicle safety feature designed to minimize the severity of injuries sustained by drivers and passengers in the event of a crash. When a vehicle stops or accelerates suddenly, a great deal of force is placed on everything inside the vehicle, including the people in the vehicle. Seatbelts help to reduce the effects of this force by distributing it across the strongest parts of the body – the chest and pelvis.

Features of Seat Belts:

It helps to prevent injuries resulting from colliding with other objects or people in the vehicle. It prevents the ejection of the occupant from the vehicle, which can often result in fatal injury. It prevents or minimizes the second impact in a crash, which causes injuries. The working of seat belts in case of immediate braking.

[3] Collapsible Steering Column:

The collapsible steering column is a type of advanced steering column. It is a part of the passive safety system in cars. Most passenger vehicles commonly employ the collapsible version instead of the regular steering column. It is also known as an 'Energy absorbing steering column'.

Features of Collapsible Steering Column:

It reduces the risk of injuries occurring to the driver in case of frontal impacts by collapsing. Energy dissipation management in the event of a frontal collision. Provide mounting for the multi-function switch, column lock, column wiring, column shroud, transmission gear selector, gauges, etc. Offer (height and/or length) adjustment to suit driver preference.

[4] Anti-lock Braking System (ABS) with EBD:

When a brake is applied suddenly with huge force the wheels get locked and go out of control resulting in an accident. ABS with electronic brake-force distribution prevents the wheels from locking and skidding. Ensuring better control even during sudden braking.

[5] Electronic Stability Control (ESC):

Many car accidents happen because the car loses control due to oversteer or understeer in corners, low traction in wet roads, etc. ESC monitors the steering wheel angle along with the car's individual wheel rotation. During an emergency, ESC applies the brake and balances the engine power to regain control.

6.Adjustable Steering:

When you are behind the wheel, you need to be comfortable. Having adjustable steering commonly known as tilt and telescopic steering will help the driver to adjust the height of the steering wheel and the distance from the driver. This reduces any sort of discomfort to the driver.

7.Tyre Pressure Monitoring System (TPMS):

A sensor is placed in each wheel to monitor the tyre pressure. TPMS sends an alert to the instrument cluster when the tyre pressure is low. It increases your car's safety on the road with better handling, reduced braking distance and better fuel economy.

END

Model Answer

Subject Name: **Subject Code:** XXXXX

Q. No.	Sub Q. N.	Answer	Marking Scheme

22656

12223

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answer with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following. **10**

a) Compare front engine front wheel drive (FEFWD) with front engine rear wheel drive (FERWD) (Any four points)

b) State working principle of centrifugal clutch.

c) Define under steering and over steering.

d) List components of a vehicle counted in sprung and un-sprung weight.

e) Write principle of working lead acid battery

f) Define HGV and MGV.

g) State need of universal joint and slip joint used in propeller shaft.

Marks

2. Attempt any THREE of the following. **12**

a) List different frames used in automobile construction. Write functions of frame.

b) List various parts of synchromesh gear box with role of each component.

c) Describe working of Disk Brake. Draw a neat sketch.

d) Explain working of gas filled shock absorbers in brief. Draw a simple sketch for the same.

3. Attempt any THREE of the following. **12**

a) Explain following terms related with car Aerodynamics.

i) Drag

ii) Lift

b) Explain Rack and Pinion type steering gear box with neat sketch.

c) State function and need of independent suspension system.

d) Explain working of starting system of a vehicle with neat sketch.

4. Attempt any THREE of following. **12**

a) Explain necessity and importance of Cable Color Codes in automobile.

b) Explain Charging system of a vehicle with neat sketch.

c) Write silent features of Motor Vehicle Act 1989. Draw any 04 traffic signs and state meaning.

d) Enlist any four gauges and sensors with their functions.

e) Draw organization structure of Motor Vehicle (RTO) department. Write role of RTO.

Marks

5. Attempt any TWO of the following. **12**

a) Describe torque converter with neat sketch. Compare it with fluid flywheel. (Any 2 points).

b) State need of ABS. Draw typical layout of ABS. Write in brief role different components.

c) List factors affecting tyre life. State the meaning of all terms involved in following tyre designation. **P215/65R16 95 H**

6. Attempt any TWO of the following. **12**

a) State significance of live and dead axle. Describe semi floating axle with sketch.

b) Draw electronic ignition system. Compare it with conventional ignition systems. (Any four Points).

c) Describe in brief different passenger safety systems adapted in modern vehicles.

WINTER – 2022 EXAMINATION

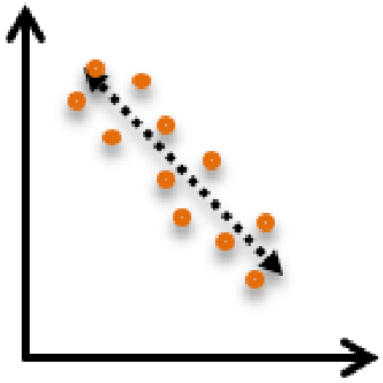
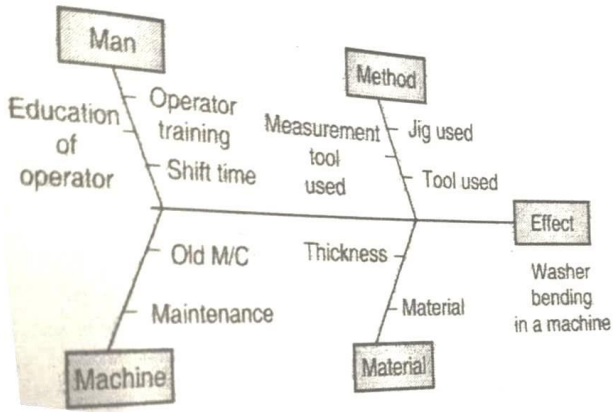
Model Answer

Subject Name: Industrial Engg. & Quality Control **Subject Code:** 22657

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.1		**Attempt any FIVE of the following**	**10 Marks**
	a)	**Define work study. Name the various steps involved in it.**	
	Sol.	**Work study:** Work study investigates the work done in an organization and aims at finding the best and the most effective way of utilizing the available resources (Men, material, money and machinery) to achieve best possible quality work which involves least possible time and causes least possible fatigue to the worker. Or Work study is a term used to embrace the techniques of method study and work measurement, which are employed to ensure the best possible use of human and material resources in carrying out a specified activity. **Steps:** 1. Select the task to be studied. 2. Record the facts 3. Examine / analyze the facts 4. Develop new method/ measure the task 5. Install new method / compile standard time 6. Maintain new method.	01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**State the important functions of process Engineering.**	
	Sol.	(i) Selection of machines (ii) Determining sequence of operation (iii) Combining operations wherever possible (iv) Specifying inspection stages (v) Specifying tools, jigs, fixtures required for process.	½ mark for each function
	c)	**Draw a scatter diagram showing negative correlation between two variables.**	
	Sol.		02 Mark for diagram
	d)	**Name the various control charts used in Statistical Quality Control.**	
	Sol.	$\bar{x}$ - R chart $\bar{x}$ - σ chart C – chart P – chart	½ mark for each
	e)	**With the help of block diagram show the basic structure of cause and effect diagram.**	
	Sol.		02 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	f)	**List out the various factors affecting quality of product.**	
	Sol.	1. Raw material used. 2. Skill of operator. 3. Environmental conditions 4. Machines used for production. 5. Calibration of instruments. 6. Proper methods of using an instrument.	½ mark for each
	g)	**Why 100% inspection is generally not preferred in the industry for mass production.**	
	Sol.	1. Cost required is more for 100% inspection. 2. Time consuming process. 3. Fatigue to the operator. 4. More staff is required for inspection. 5. More material handling so more chances of material damage.	½ mark for each
Q.2		**Attempt any <u>THREE</u> of the following:**	**12 Marks**
	a)	**Explain in brief different "Recording Techniques" used in method study.**	
	Sol.	The success of procedure depends upon the accuracy with which the facts are recorded because they will provide the basis of both the critical examination and the development of the improved method. All the facts relating to selected jobs are recorded in forms, charts and diagrams. (a) Charts: Indicating process sequence (i) Outline process chart (Records only main events) (ii) Flow process chart (Records all events) 1. Man Type 2. Material type 3.Machine / Equipment type (b) Charts: Using a time scale (i) Multiple activity chart (ii) SIMO Chart (c) Models and diagrams: Indicating movements (i) Flow diagram (ii) String diagram (iii) Cycle graph (iv) Chrono cycle graph (v) Two-three dimentional models	01 Mark 01 Mark 01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**Explain "Part Print Analysis'. Which information does the process Engineer seeks from it.**	
	Sol.	Preliminary part print analysis is the first step in process planning. The product design is conveyed by design department to process engineer in the form of part print. It is also called as part drawings or blue prints. The part drawing consists of a variety of information which helps in planning the process. The detailed study or interpretation of part drawing under consideration for the manufacturing of the part is called as part print analysis. Part print consists of following information: • Part geometry • Dimensions and associated tolerances • Geometrical tolerances • Surface finish specifications • Material specifications • Quantity of parts required Preliminary analysis is done in order to get a general visualization of the complete manufacturing of the part. **General characteristics of the workpiece** The process engineering department tries to determine following requirements from the detailed study of part print. These are: 1. The general description of the part. 2. The general configuration of part. 3. The material from which the part is made. 4. Originating operation of part. 5. Recording of changes in design. 6. Protection of workpiece during manufacture. **Working drawing:** • Working drawing is referred to all those drawings are reference drawings from which, the parts are manufactured. • These drawings includes part drawings of individual component and sub assembly drawing and final assembly drawing • Working drawing consists of conventions of process, tolerances, surface finish, machining symbols etc. • Working drawings are also referred as production drawings. The drawings represent details of product, its size, shape, material, processes, and tools equipment. • The operator is completely guided by the working drawings during the manufacturing of the product. These are the legal and authentic documents of the company.	01 Mark 01 Mark 01 Mark 01 Mark

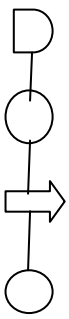
Q. No.	Sub Q. N.	Answer	Marking Scheme
	c)	**With the help of a block diagram show the sequence of activities for any quality characteristics.**	
	Sol.	**Quality Characteristics:** • For the refrigerator, it is described by using colour of body, capacity of the refrigerator, brand of the compressor, warranty, service conditions, etc. These are called as 'quality characteristics'. • The quality characteristics are grouped as: a) Structural type: Length, height, diameter, viscosity, etc. b) Look type: Test, colour, texture, appearance, etc. c) Time oriented: Safety, reliability, service, failures, etc. d) Commercial Cost, discount, warranty, packing, etc. • If also above conditions are applicable for the 'quality of product', similar characteristics are used for 'quality of service". • For service sectors like banking, postal services, transportation, bus services, hospital services, etc. In these all above service characteristics are also used • In banking : satisfaction of consumers, transaction accuracy, prompt time to time service, telephonic internet banking, clarity in transaction space – infrastructure of bank, ATM services, opening hours of banks, interest/loan facility, reliability i.e. accuracy of services, image, honesty, responsiveness of bank, etc.	01 Mark 01 Mark 01 Mark 01 Mark
	d)	**What is the effect of various environment factors such as temperature, noise, light on the efficiency of operator.**	
	Sol.	**Environment factors:** Working conditions are those which surround the worker as he performs his task. Working conditions affect his physical well-being and therefore his efficiency towards work. Some of the working conditions are mentioned below. **1. Temperature:** It includes the temperature, humidity and air flow. Poor heat and humid conditions produce thermal stresses in the worker which affect their efficiency, concentration and dexterity of their members of body. Working temperature of 60-65 ^{0}F is considered as normal but it varies according to nature of work. Humidity and heat are related to each other both affect comfort and tolerance of the body to heat. The effect of heat can be minimized by shielding isolating best sources, by installing and providing local ventilation by permitting breaks or rest pauses in cool or extreme hot conditions.	01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
		2. Noise: Noise is defined as unwanted sound and it has been shown to have both short and long term effects on performance. Noise is the cause of various problems like fatigue, imitation, reduced productivity and accidents. To reduce the noise: 1. Control the noise at source. 2. By proper machine lubrication maintenance, padding and by providing noise mufflers 3. Using noise absorbers 4. Provision of ear plugs S. Improved workplace layout. **3. Light** Most of the time man depends upon sunlight as a natural source of light. But sometimes of weather conditions and in nights. When shop activities are carried out indoors or at night, it is necessary to provide artificial light. Visibility depends on size and colour of product, its distance from eyes, intensity of light, contest of colour these factors must be studied precisely in case of accurate works, work in dangerous environment or in case of poor working conditions. The lighting system should provide: 1. Sufficient brightness 2. Uniform illumination 3. A contrast between brightness of the job and of background 4. No direct or reflected glare	01 Mark 01 Mark
Que.3		**Attempt any <u>THREE</u> of the following**	**12 Marks**
	a)	**Define process chart, draw the various symbols used in process chart.**	
	Sol.	A chart representing process is called process chart	

Q. No.	Sub Q. N.	Answer	Marking Scheme
			01+03 Mark

Event	Symbols
Operation	
Storage	
Delay or Temporary storage	
Transport	
Inspection	
Operation cum –transportation	
Inspection cum –operation	

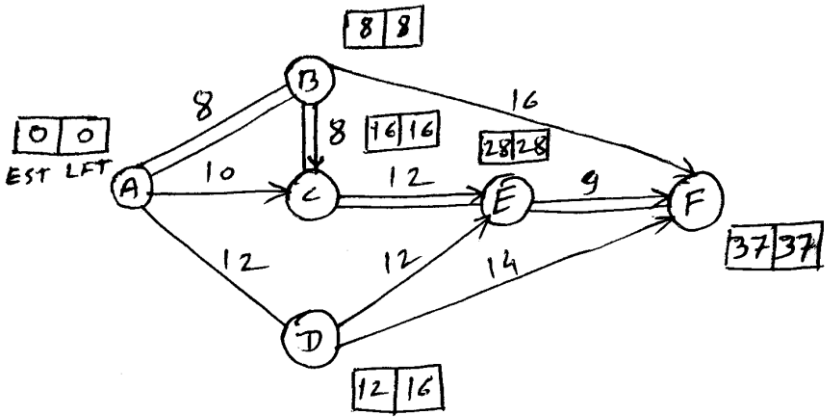
	b)	**Define anthropometry and explain its importance.**	
	Sol.	Anthropometry is defined as , " the branch of ergonomics, which deals with shape and size of body". Anthropometry is defined as "The scientific study of measurement and proportions of the human body, which involves the systematic measurement of dimensional description of size and shape of human body". Anthropometry play an important role in industrial design , clothing design , ergonomics and architecture , where statistical data about the distribution of body dimensions in the population are used to optimize products.	02+02 Mark
	c)	**Draw a two handed process chart to assemble a nut and bolt.**	
	Sol.		03+01 Marks

Job: Assemble a nut and bolt			
Left hand	Symbols L. S.	Symbols R. H.	Right hand
Pick up bolt			Idle
Hold			Pick up nut
Hold			To left hand
Hold			Assemble (Screw up)

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td></td><td></td><td>Summary
<table>
<tr><th colspan="2">Lift hand</th><th colspan="2">Right hand</th></tr>
<tr><td>  </td><td>01</td><td>  </td><td>02</td></tr>
<tr><td>  </td><td>03</td><td>  </td><td>00</td></tr>
<tr><td>  </td><td>00</td><td>  </td><td>01</td></tr>
<tr><td>  </td><td>00</td><td>  </td><td>01</td></tr>
</table></td><td></td></tr>
<tr><td></td><td>d)</td><td>Classify the man – machine system</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>a) Based on the importance of feedback
- Open loop system
- Closed loop system
b) Based on the type of processing
- Manual Systems
- Semi- automatic Systems
- Automatic Systems
c) Based on the number of men and machines
- One to one Man – Machine System
- Many to one type Man- Machine System
- One to many Man - Machine System
- Many to many Man – Machine system</td><td>04 Mark</td></tr>
<tr><td>Que.4</td><td></td><td>Attempt any <u>THREE</u> of the following</td><td>12 Marks</td></tr>
<tr><td></td><td>a)</td><td>State any four advantages of Ergonomics (any 4)</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>1. Higher productivity
2. More the human comfort, less the fatigue to operator.
3. Better deign to machine.
4. Increase the safety.
5. Better integration of man –machine system.
6. Reduced labour turnover</td><td>01 Mark for each</td></tr>
</table>

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**Describe any two of the following in connecter with a man – machine system** **i) Design of visual display** **ii) Design of control** iii) **Design of workplace**	
	Sol.	**Design of visual display** - Display are the device, through which, the man can receive the information from the machine. - A good display is one, which allows proper combination of speed, accuracy and sensitivity of display. - Display provides primary and secondary information needed by operators in making decisions and in effecting control responses. - Information presented by display can be considered as dynamic or static - Two broad categories of display are 1. Visual display 2. Auditory display - Depending upon the type of information provided by visual display, Visual display can be further classified into two subgroups. i) Qualitative display – Indicating only the condition or state without giving any values. ii) Quantitative Displays- Give numerical information about the equipment or machine Auditory display can make monitoring performance superior **Design of control** A control is a device which can transmit information to some machine, mechanism or a system. Thus a control is selected based upon the nature of information desired to be transmitted. The performance efficiency of a human operator is affected by the nature/type of controls provided with any machine. A proper design goes a long way in making the work of operator easy. A proper control for any machine should be the optimum for the machine. Factor Affecting the Selection of a Control Device: 1. Operational Functions of the Control 2. Need of control task. 3. Informational Need of operator 4. Space and layout requirement	Any two 02+02

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td></td><td></td><td>Design of workplace
Working environment is another very important factor which requires consideration in the design of man-machine systems.
The environment in which a worker/operator performs his job has a big influence on the following:
(i) The fatigue or the strain a worker acquires in performing his task.
(ii) The productivity of the system.
Even the optimum work methods would not help if the workplace layout or the working environment where the operator work has.
Unbearable noise.
Insufficient light leading to poor visibility ‘smoke and fumes, and uncleanness etc.
Thus an operator’s performance and comport are dependent upon proper design of work space. Our aim is to arrive at optimum location and arrangement of each component essential for smooth working.
These components affecting workers task may be as follows:
1. Equipment’s.
2. Seating arrangement.
3. Displays.
4. Controls.
5. Materials.
6. Working space.</td><td></td></tr>
<tr><td></td><td>c)</td><td>Enlist the benefits of kaizen.</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>Benefits of kaizen
1. Increased Productivity
2. Improve Quality
3. Reduced Cost
4. Faster Deliveries
5. Improve Safety
6. Process standardization
7. Waste reduction</td><td>Any Four 01 Mark for each</td></tr>
<tr><td></td><td>d)</td><td>What is meant by “5S” Explain each “S” in detail.</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>
<table>
<tr><th>Japanese term</th><th>English</th><th>Explanation</th></tr>
<tr><td>1.Seiri (tidiness)</td><td>Sort</td><td>Remove unnecessary items from each area</td></tr>
<tr><td>2.Seiton (orderliness)</td><td>Set In Order</td><td>Organize and identify storage for efficient use</td></tr>
<tr><td>3.Seiso (cleanliness)</td><td>Shine</td><td>Clean and inspect each area regularly</td></tr>
<tr><td>4.Seiketsu (standardization)</td><td>Standardize</td><td>Incorporate 5S into standard operating procedures</td></tr>
<tr><td>5.Shitsuke (discipline)</td><td>Sustain</td><td>Assign responsibility, track progress, and continue the cycle</td></tr>
</table>
</td><td>04 Mark</td></tr>
</table>

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.5		**Attempt any TWO of the following**	**12 Marks**
	a)	**Critical Path**  Forward Pass → Max. Backward Pass → Min. Critical Path (C.P.) = A 8 B 8 C 12 E 9 F	Network Diag. 4m C.P. 2m
	b)	**Task**- Replacement of punctured tyre. **Chart begins**- Jack up the car. **Chart ends**- Remove the jack. **Checked by**- Mr. ABC **Date of charting**- DD/MM/YYYY 1 Jack up the car. 2 Remove all nuts of a wheel. 3 Remove the old/punctured wheel/tyre. 4 Fit the new wheel/tyre. 5 Fit all the nuts. 6 Tighten all the nuts by spanner. 7 Check the tyre pressure & movement. 8 Remove the jack. Summery Symbol | Freq. ○ | 07 □ | 01	6 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	c)	Given: $\Sigma X = 357.50$, $\Sigma R = 9.90$, Number of Subgroups = $N = 20$; $A_2 = 0.18$, $D_3 = 0.41$, $D_4 = 1.59$, $d_2 = 3.725$	
		Calculating Grand Average ($\bar{\bar{X}}$) and Average Range $\bar{R}$.	01 Mark
		i.] $\bar{\bar{X}} = \frac{\Sigma X}{N} = \frac{357.50}{20} = 17.875$.	
		ii.] $\bar{R} = \frac{\Sigma R}{N} = \frac{9.90}{20} = 0.495$	
		① Control Limits of $\bar{X}$ Chart:-	02 Mark
		i.] UCL $\bar{X} = \bar{\bar{X}} + A_2 \cdot \bar{R} = 17.875 + (0.18 \times 0.495) = 17.964$	
		ii.] LCL $\bar{X} = \bar{\bar{X}} - A_2 \cdot \bar{R} = 17.875 - (0.18 \times 0.495) = 17.786$	
		$\therefore$ UCL $\bar{X} = 17.964$	
		$\therefore$ LCL $\bar{X} = 17.786$	
		② Control Limits of R Chart:-	02 Mark
		i.] UCL $R = D_4 \times \bar{R} = 1.59 \times 0.495 = 0.78705$	
		ii.] LCL $R = D_3 \times \bar{R} = 0.41 \times 0.495 = 0.20295$	
		$\therefore$ UCL $R = 0.78705$	$\therefore$ LCL $R = 0.20295$
		③ Finding Process Capability:-	01 Mark
		Process Capability = $6\sigma' = 6\frac{\bar{R}}{d_2} = 6 \times \left(\frac{0.495}{3.725}\right) = 0.797$	
		$\therefore$ Process Capability ($6\sigma'$) = 0.797	

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.6		**Attempt any TWO of the following**	**12 Marks**
	a)	**Objectives of Line Balancing** (six objectives for 6 marks) 1. To equalize the workload among the workers Workload should be distributed equally at each stage of assembly line wrt overall assembly time. 2. To identify the bottleneck operation Identify the bottleneck operation and improve the stage by doing some modifications or corrections. 3. To eatablish the speed of production line To divide the work properly wrt worker's movements. Sometime, combine the operations for improvement the speed of production line. 4. To deterine the number of workstations. Industrial Engineer should do the time study of each stage and as per sequence of assembly determine the number of workstations for completing all assembly operations. 5. To determine the percentage worklod of each operator Workload at each stage should be distributed equally in terms of percentage too. 6. To assist in plant layout Line balancing can be done in such a way that it should utilize the minimum space in a factory. Therefore, space saving can be possible and effective plant layout should be possible	01 Mark for each
	b)	Given:-	

Assembly No.	1	2	3	4	5	6	7	8	9	10
No. of Defects.	2	3	2	5	2	3	5	3	0	1

For 'c' Chart

we have,

1.] Central line = $\bar{C}$ = $\frac{\text{Number of Defects in all Assemblies}}{\text{Total Number of Assembly.}}$

$= \frac{2+3+2+5+2+3+5+3+0+1}{10}$

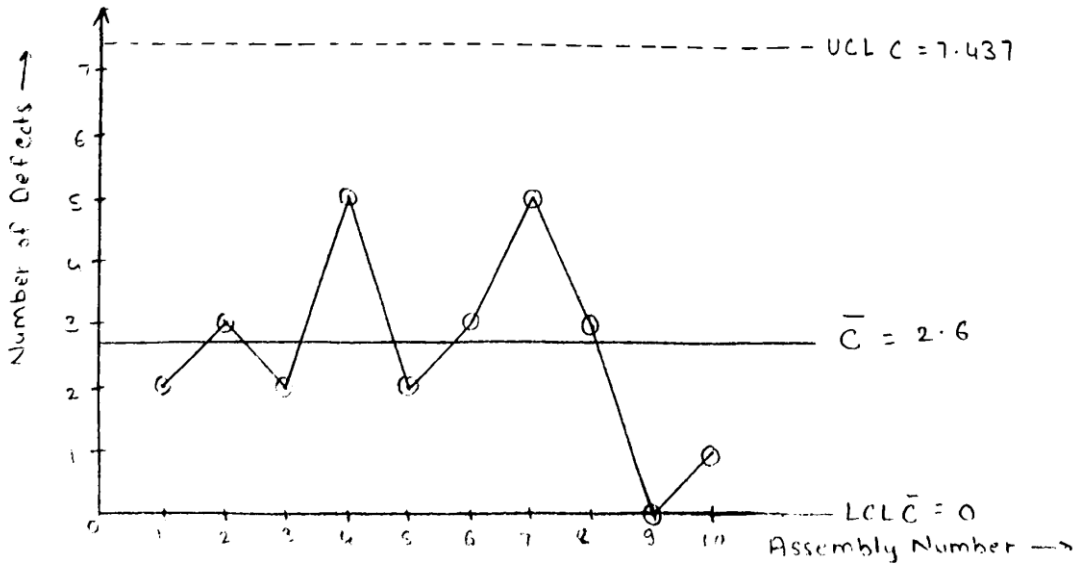
$= \frac{26}{10} = 2.6.$ $\therefore \bar{C} = 2.6$ — 01 Mark

2.] Control Limits for 'C' Chart :-

UCL $c = \bar{c} + 3\sqrt{\bar{c}} = 2.6 + 3\sqrt{2.6} = 7.437$

LCL $c = \bar{c} - 3\sqrt{\bar{c}} = 2.6 - 3\sqrt{2.6} = -2.23 \cong 0$ — 02 Mark

$\therefore$ UCL $c = 7.437$ $\therefore$ LCL $c = 0$

Q. No.	Sub Q. N.	Answer	Marking Scheme
		3] Construction of 'C' Chart  4] Conclusion :- As all the points lie between the control limits, Hence, Process is in Control.	02 Mark 01 Mark
	c)	**Machine- A** Given : Sample Size (n) = 200 No. of Sample = 10 + Procedure for Plotting P Chart :- (1) Calculate fraction defective of each sample :- For first sample, $p = \frac{\text{Number of defective}}{n} = \frac{25}{200} = 0.125$ Accordingly, we get	

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	25	28	30	30	20	29	31	26	31	27
Fractional Defective	0.125	0.14	0.15	0.15	0.1	0.145	0.155	0.13	0.155	0.135

(2) Central Line of P- Chart :- (Average Fractional Defective.)

$$\bar{P} = \frac{\text{Total No. of defectives in all Sample}}{\text{Total No. of Components inspected}} = \frac{[25+28+30+30+20+29+31+26+31+27]}{10 \times 200}$$

$$\therefore \bar{P} = 0.1385$$

01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme

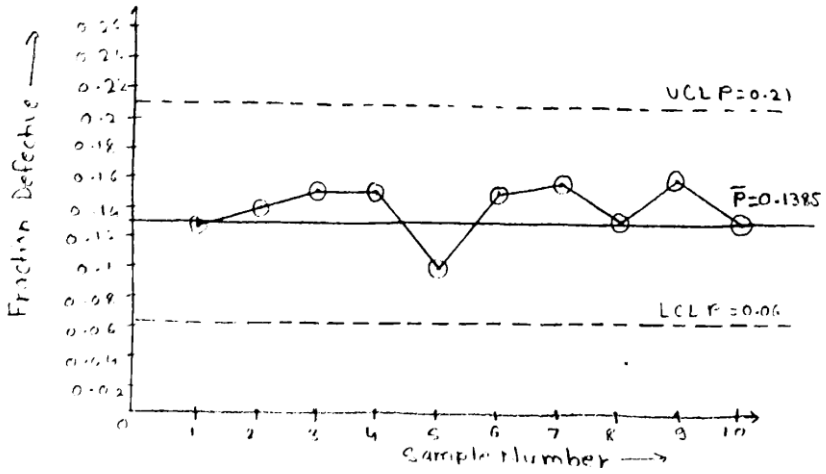
③ Control Limits for P Chart :-

i.] $UCL\ P = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.1385 + 3\sqrt{\frac{0.1385\,(1-0.1385)}{200}} = 0.21$

ii.] $LCL\ P = \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.1385 - 3\sqrt{\frac{0.1385\,(1-0.1385)}{200}} = 0.065$

01 Mark

④ Construction of P Chart.



Conclusion :-
As all the point lie between the control limits, the process is in control.

01 Mark

Machine- B

Similarly, for machine B Sample size (n) = 200
No. of Sample = 10

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	11	08	22	15	12	27	10	15	10	02
Fractional Defective	0.055	0.04	0.11	0.075	0.06	0.135	0.05	0.075	0.05	0.01

i] Central line of P-Chart :-

$$\bar{P} = \frac{\text{Total Number of Defective in all Sample}}{\text{Total Number of Component inspected.}} = \frac{[11+08+22+15+12+27+10+15+10+02]}{10 \times 200}$$

$$\therefore \bar{P} = 0.066$$

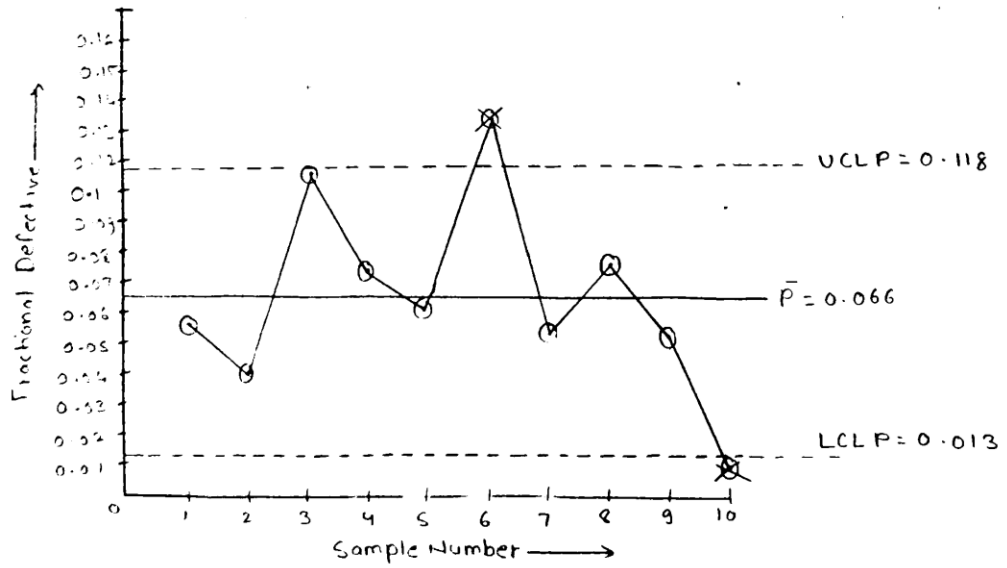
01 Mark

ii.] Control limits for P Chart :-

1) $UCL\ P = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.066 + 3\sqrt{\frac{0.066\,(1-0.066)}{200}} = 0.118$

2) $LCL\ P = \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.066 - 3\sqrt{\frac{0.066\,(1-0.066)}{200}} = 0.013$

01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
		iii.] Construction of P-Chart:-  iv.] Conclusion:- As point (6) and (10) is lying out of control limits, the process is out of control.	01 Mark

22657

12223

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define work study. Name the various steps involved in it.

b) State the important functions of Process Engineering.

c) Draw a scatter diagram showing negative corerelation between two variables.

d) Name the various control charts used in Statistical Quality Control.

e) With the help of a block diagram show the basic structure of cause and effect diagram.

f) List out the various factors affecting quality of product.

g) Why 100% inspection is generally not prefered in the industry for mass production.

2. Attempt any THREE of the following: 12

a) Explain in brief different "Recording Techniques" used in method study.

b) Explain "Part Print Analysis". Which information does the process Engineer seeks from it.

c) With the help of a block diagram show the sequence of activities for any quality characteristic.

d) What is the effect of various environment factors such as temperature, noise, light on the efficiency of operator.

3. Attempt any THREE of the following: 12

a) Define process chart, draw the various symbols used in process chart.

b) Define anthropometry and explain its importance.

c) Draw a two handed process chart to assemble a nut and bolt.

d) Classify the man-machine systems.

4. Attempt any THREE of the following: 12

a) State any four advantages of Ergonomics (any 4)

b) Describe any two of the following in connecter with a man-machine system

i) Design of visual display

ii) Design of Controls

iii) Design of workplace

c) Enlist the benefits of Kaizen.

d) What is meant by "5S" Explain each "S" in detail.

5. Attempt any TWO of the following: 12

a) In a project, there are 6 events. Their precedence relationships are A∠B, A∠C, A∠D, B∠F, B∠G, C∠E, E∠F, D∠E, D∠F The activity between different events consume time as mentioned in table below. Identify the critical path. (Ref. Fig. No. 1)

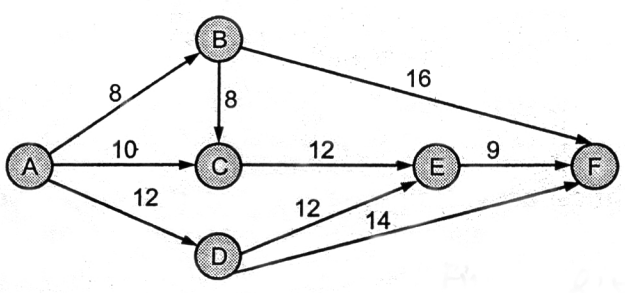


Fig. No. 1

Marks

b) Outline an appropriate process chart for the activity "Replacement of Punctured Tyre".

c) Determine the control limits for $\overline{X}$ and R charts if $\Sigma X = 357.50$, $\Sigma R = 9.90$, Number of subgroups = 20. Given $A_2 = 0.18$, $D_3 = 0.41$, $D_4 = 1.59$ and $d_2 = 3.725$. Also find the process capability.

6. Attempt any TWO of the following: **12**

a) Explain any six objectives of line balancing.

b) Number of defects found in an inspection of 10 assemblies are 2, 3, 2, 5, 2, 3, 5, 3, 0, 1 respectively. Draw C Chart and conclude.

c) Two machines producing components are checked up for the statistical stability. Draw the 'P' chart for both machines and comment upon the process. Sample size for both machines are 200.

Machine A

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	25	28	30	30	20	29	31	26	31	27

Machine B

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	11	08	22	15	12	27	10	15	10	02

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Technologies **Model Answer** Subject Code: 22661

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	(a)	Classify Energy Sources **A.Primary energy sources** 1. Coal 2. Crude Oil 3. Natural gas 4. Biomass 5.Solar Energy 6.Hydropower energy 7.Wind Energy **B.Secondary energy sources** 1.Heat 2.Electricity 3.Petroleum 4.Biofuels **C.Tertiary Energy Sources** 1.Tidal Energy 2.Nuclear Energy	½ mark each (any four)
	(b)	**State application of biofuels** 1. Transportation 2. Energy generation 3. Cooking 4. Solvent 5. Germicide 6. Alcoholic beverage 7. Fuel 8. Depresent & as chemical intermediate 9. Fuel for Automobiles, use as additive to petrol	½ mark each (any four)

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Technologies **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
	(c)	**Types of Solar Panels** 1. First Generation Solar PV panels e.g. mono crystalline and polycrystalline 2. Second Generation Solar PV panels e.g. Thin film, Amorphous silicon 3. Third Generation Solar PV panels e.g. Cadmium Teluride, Copper, Indium, Galium, Selenide	02 marks
	D	**Specifications of HAWT** Note :- any other specifications of such type may be considered.	02 marks
	e	**Components of micro hydro power system** 1. Diversion structure 2. Desalting Tank 3. Water channel 4. Forebay Tank 5. Penstock 6. Turbine 7. Generator 8. Power house 9. Tail race	02 marks
	f	**Merits of PV cells** 1. Very long life 2. No moving parts 3. No noise 4. No pollution 5. High reliability 6. Easy operation and maintenance 7. System Fabrication is easy 8. Threshold required power is less 9. Unlimited renewable source 10. May be installed in remote areas.	02 marks

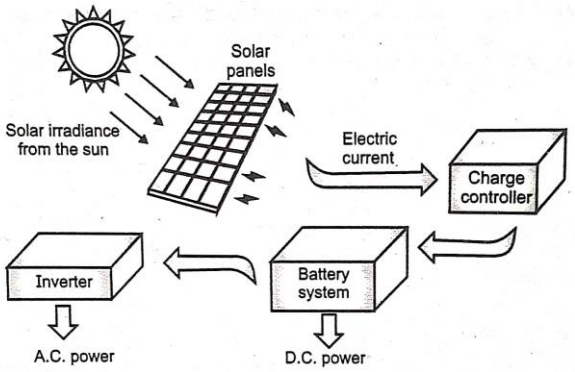
Sr.no	Name of specification	Details
01	Rated power	2.7 MW
02	Rated wind speed	9.5 m/s
03	Cut-in wind speed	3 m/s
04	Cut-out wind speed	30 m/s
05	Rotor diameter	129 m
06	Generator	50 Hz/ 60 Hz
07	Tower	140 m

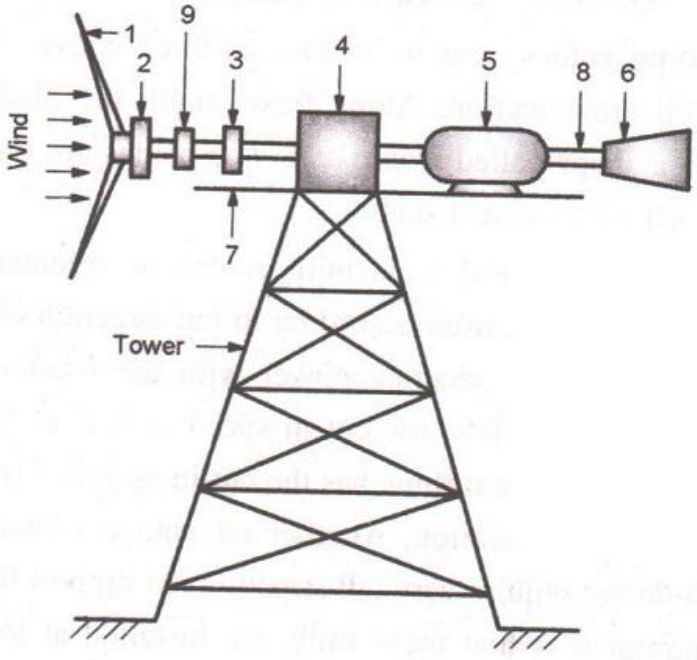
SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	g	**Hybrid systems** 1. Wind solar photovoltaic hybrid system 2. Wind biomass hybrid system 3. Solar biomass hybrid system 4. Solar diesel hybrid system 5. Solar gas turbine hybrid system 6. Combination of any two power generation plants	02 marks
2	a	**Distinguish between renewable and nonrenewable energy sources**	04 marks
	b	**Types of Solar Photovoltaic Systems** 1. Grid connected Solar PV Systems 2. Off grid / stand alone Solar PV Systems 3. Hybrid – connected Solar PV Systems	04 marks

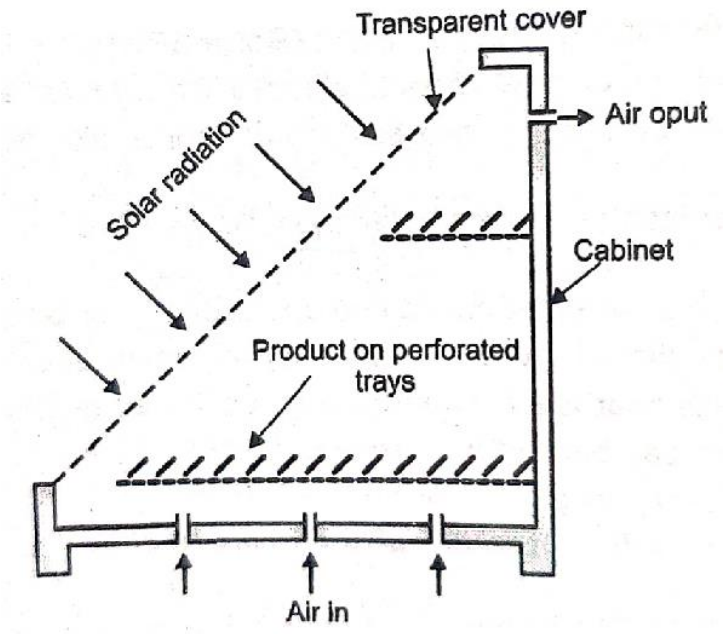
Sr No.	Renewable energy sources	Non renewable energy sources
1	Renewable energy sources are essentially inexhaustible	Non Renewable energy sources are exhaustible and likely to be depleted with passage of time.
2	Can be harnessed without the release of harmful pollutants	Produce pollution
3	More capital cost	Less capital cost
4	Ex. Solar , wind power, geothermal , tidal etc	Ex: coal , oil , gas etc



2	c	A solar PV cells are used to supply power to a house where DC power is converted to AC power supply to house hold appliances. The solar PV cells converts the solar energy to electricity by using Photovoltaic effect as shown in figure. **Structure of horizontal axis wind mill**  Components:- 1. Rotor with blades 2. Electromagnetic brakes 3. Mechanical brakes 4. Gear box 5. Generator 6. Flap or tail vane 7. Tower top 8. Shaft 9. Controller	04 marks

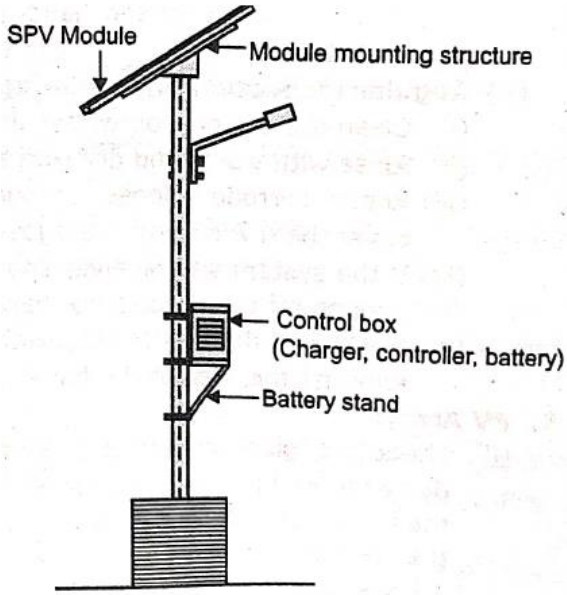
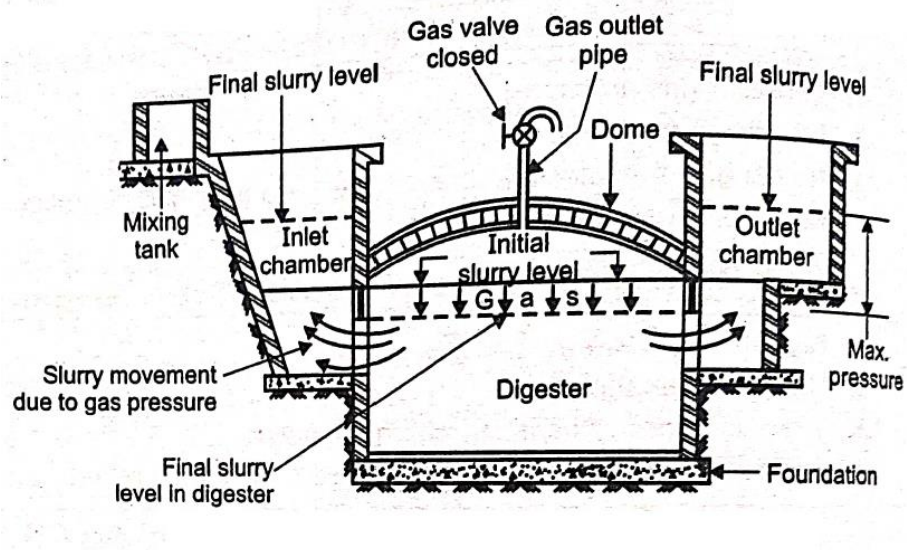
SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
2	d	Micro hydel power plant is a type of hydroelectric power that typically produces from 5 kW to 100 kW of electricity using the natural flow of water. These installations can provide power to an isolated home or small community, or are sometimes connected to electric power networks, particularly where net metering is offered. There are many of these installations around the world, particularly in developing nations as they can provide an economical source of energy without the purchase of fuel. Micro hydro is frequently accomplished with a **Pelton** wheel for high head, low flow water supply. The installation is often just a small dammed pool, at the top of a waterfall, with several hundred feet of pipe leading to a small generator housing.	04 marks
3	a	**Working of Solar Dryer**  Solar radiations enters the enclosure and it is absorbed by the products as well as surrounding internal surfaces the products are directly heated by solar radiations., moisture from the products as the air inside is heated which follows decrease in density and rise in temperature , therefore low dense air moves up word and leaves through the openings provided at top of cabinet dryer and at the same time fresh air enters. The temp. inside the cabinet ranges from 50^0 c to 75^0 c the drying time for products varies from 2 to 4 days.	04 marks

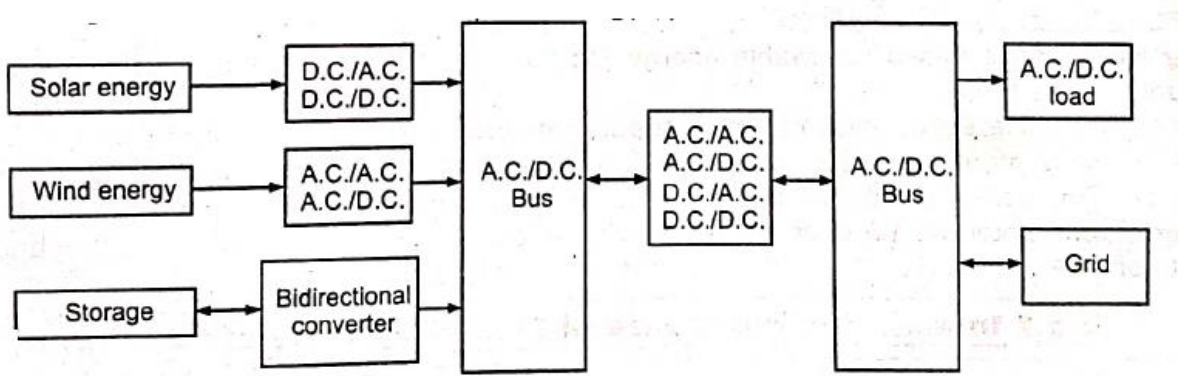
SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
3	b	**Stand alone street light system**  A stand-alone solar photovoltaic street lighting system comprises following compo-nents: 1. Foundation, 2. Solar panel with frame, 3. LED lamps, or compact fluorescent (CFL) lamp, 4. Light pole, 5. Control box (charger, controller, battery, wires etc.).	04 marks
	C	**Fixed dome biogasplant**  The cattle dung and water are mixed properly in the ratio 1:1 to form slurry, which is then filled in the digester up to height of its cylindrical portion. The fermentation fixed up and gas is generated this gas is collected through the pipe line provided at the top and slurry is released through outlet chamber.	04 marks

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No	Sub Q. N	Answer	Marking Scheme
3	d	**Biomass** Biomass is defined as all plant and animal matter on the earth surface. **Biomass energy** Energy obtained from Biomass is called Biomass energy**.** Biomass Resources: 1. Wood 2. Energy crops 3. Agricultural residues a) Grass b) Tree leaves c) Wheat straw d) Rice husk e) Sugarcase bagasse 4. Food waste 5. Industrial waste and co-products etc.	04 marks
4	a	**Wind solar hybrid system**  Wind solar hybrid system work in stand alone or grid connected mode in which AC power output is directly connected to the utility grid through transformer. In this system solar energy and wind energy are key resource used to generate electricity.	04 marks

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

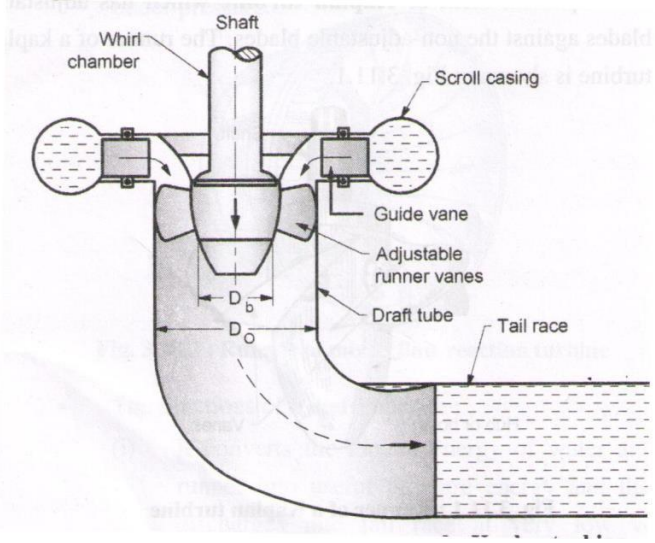
Q. No.	Sub Q. N.	Answer	Marking Scheme
4	b		04 marks

Sr. No.	Comparative Point	Horizontal Axis Wind Turbine	Vertical Axis Wind Turbine
1.	**Axis of rotation**	Horizontal.	Vertical.
2.	**Space required**	HAWTs needs to be placed appropriately on large distances.	VAWTs occupy a smaller footprint. Therefore, they can be used in confined physical locations or can be positioned close together.
3.	**Need of yaw control**	Required.	Not required.
4.	**Cut in speed**	High (>10 m/s).	Low (2 m/s).
5.	**Tip to speed ratio**	High (> 5)	Low (≈ 1 for Savonius)
6.	**Installation of generator**	Generator is placed at top.	Generator is placed at ground.
7.	**Maintenance cost**	Very high.	Relatively less.
8.	**Need of guy wires**	Does not required to be supported by guy-wires, tower foundation is sufficient.	A very large bending moment is created in the rotor shaft, if it is not supported at the top.

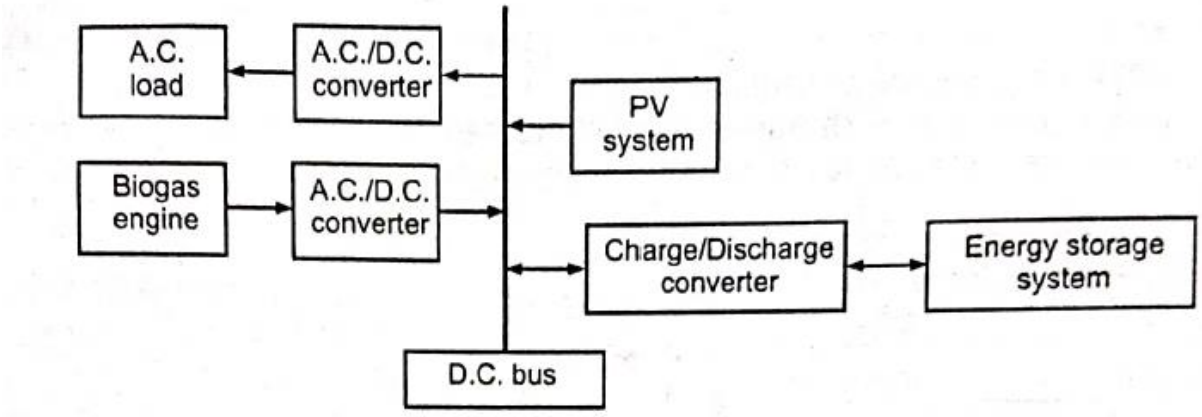
c

Propeller type reaction turbine:

IT is a axial flow reaction turbine in which water flows parallel to the axis of shaft. It has a vertical hollow shaft which is enlarged at the bottom in the shape of propeller called hub or boss. The vanes are fixed on the hub which acts as the runner. It has scroll casing guide mechanism and draft tube .



04 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	d	**Preventive Maintenance of Hydro Power Plant** Preventive maintenance is planned maintenance of plant and equipment. It is designed to improve equipment life and avoid unplanned maintenance activities. Preventive maintenance is the inspection, replacement, repair of any piece of equipment and set parameters. It includes painting, lubrication, cleaning, adjusting and minor component replacement to extend the life of equipment and facility. Its main purpose is to minimize break down deterioration. **Necessity** Good condition of Power plant for longer period To avoid the accidents with operator Water way facilities, electric equipment, transmission and distribution lines work properly.	04 marks
	e	 The biogas engine coupled with generator used for power generation from biogas. A.C./D.C. convertors rectify the generated A.C. voltage from the biogas engine generator to a D.C> voltage to be feed into the D.C. bus. D.C. power output from the solar PV system is also feed to the common D.C. bus shown in figure. A standard charge controller is used to charge the battery. A static frequency convertor converts the D.C. voltage from all sources into an A.C. voltage for consumer use.	04 marks

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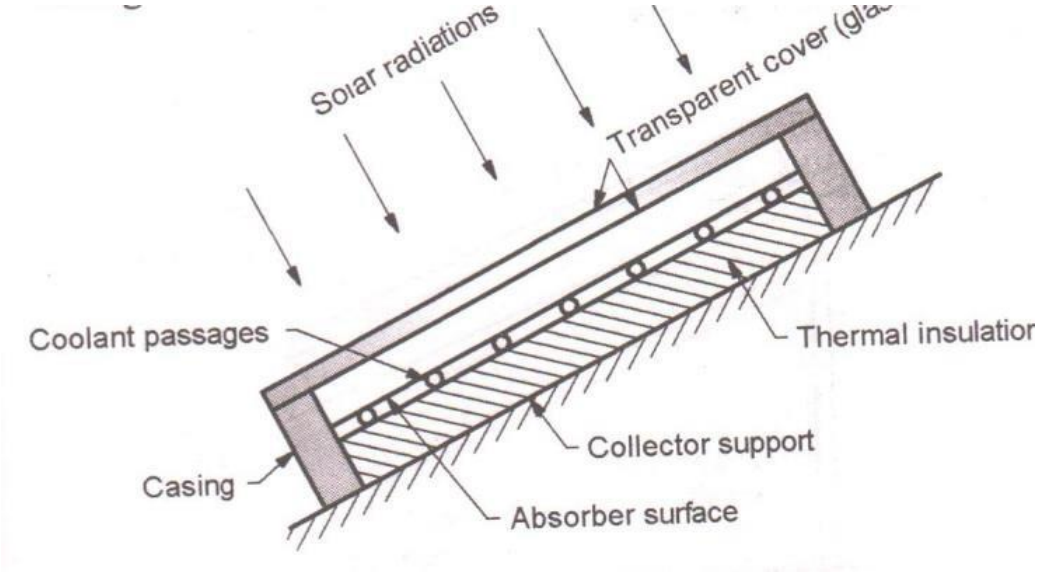
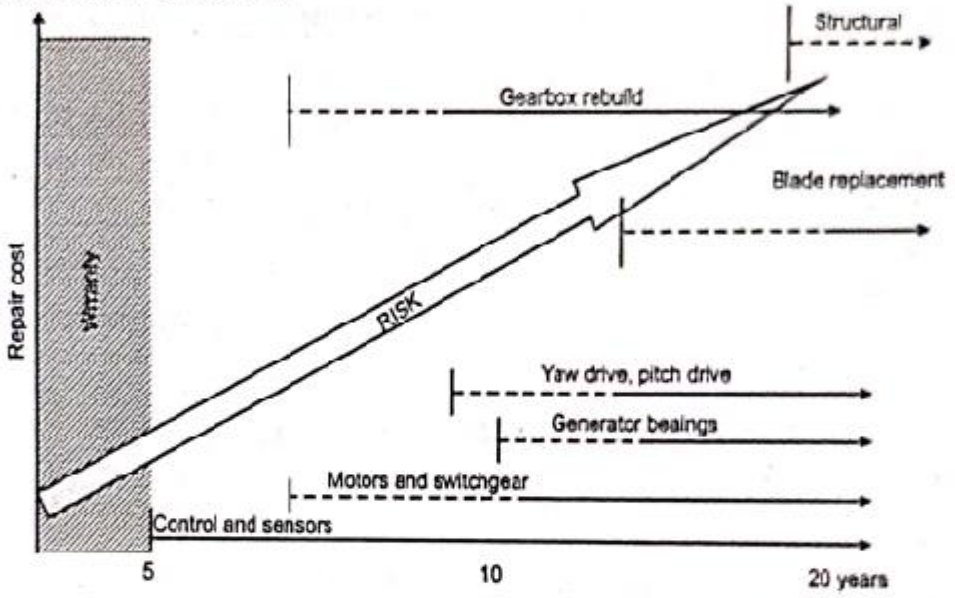
Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
5	a	**Flat plate collector** Important parts of liquid flat plate collector are shown 1. Transparent cover 2. Absorber plates 3. Tubes fixed to absorber plate to form coolant passages 4. Thermal insulation 5. Casing or container. 6. It is a box like structure. It consists of an absorber plate which receives beam as well the diffuse solar radiations through transparent glass covers. The absorbed radiations are partly transferred to the liquid flowing through tube which is either fixed to the absorber plate or they form an integral part of it. Remainder part of the radiation solar energy absorbed by the absorber plate is either re radiated to the surroundings through the top surface or lost by convections.  	06 marks

5	b	**Solar Roof top Installation Process** **1. Laying Out the Framework:** This phase of the array installation consists of three stages: (i) **Completing the basic layout of footers and rails:** Mapping the location of the racking and PV modules on paper. (ii) **Locating rafters (or trusses) for footers:** Measuring for the precise locations of the roof framing members that you will anchor into. (iii) **Snapping chalk lines and marking pilot holes:** Creating reference lines on the rooftop and marking pilot holes for installing the footers. **2.** Installing footers and rails, which will act as a mounting base for the modules. **3.** Once the footers and rails are in place, aligned and secured, the process of assembling the pre-fabricated parts of PV module is initiated. **4. Installing the microinverters and ground wire:** This includes following steps: (i) Mount all microinverters to the rails. (ii) Connect the microinverters together and cap-off the last microinverter lead. (iii) Connect the ground wire to each microinverter case or mounting bracket, as directed. (iv) Run the wire to the junction/combiner box location, leaving enough loose or flexible, for wiring into the box later. **5. Install the junction box:** Mount the electrical box of a suitable size to the mounting frame. With microinverters, junction box will be used with A.C. as an input, while with string inverters, disconnecting D.C. junction/combiner box will be installed. **6. Installing the modules:** Set the first module onto the rails at one end of the row (if the array has multiple rows, start at the bottom row). Make sure that, the module is centered top-to-bottom and it is square to the rails. Connect the module leads to the rail-mounted microinverter or D.C. optimizer, and in case of the frame-mounted microinverters, connect the microinverter to the A.C. trunk cable. **7.** Similarly, set all remaining modules and connect its leads to microinverter. **8.** Installing conduit and wiring between the combiner or junction box at the array and the system components at ground level (i.e. inside house). **9. Installing the ground-level components:** (i) Install D.C.-A.C. inverter and Rapid-shutdown control, if string inverter system is used. (This step could be skipped in the case, where microinverters have already been spaced as stated in previous steps). (ii) Installing A.C. disconnect, PV production meter, A.C. breaker(s) and utility meter.	06 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
5	c	The operation and maintenance procedure should be based on guidelines specified by the wind turbine supplier and any other suppliers. This is necessary for the effective performance of the wind energy conversion system. However, in general, the maintenance includes the following elements: 1. Routine checks 2. Periodic maintenance 3. Periodic testing 4. Blade cleaning 5. Electrical equipment maintenance 6. Unscheduled maintenance.  **Fig. 3.14: Repair cost and failure events of typical small/large size wind machine** Generally, maintenance is divided into three categories. **Corrective maintenance:** ○ Corrective maintenance is carried out after a failure has occurred. ○ This means that, the working of wind mill has to be stopped, until the failed component is either repaired or replaced by a new one. **Preventive maintenance:** ○ Preventive maintenance activity is carried out at predetermined schedule to reduce the probability of failure or the degradation of the functioning equipment. ○ Preventive maintenance activities are planned and periodical. ○ Preventive maintenance can be divided into two categories: (I) **Indirect preventive maintenance:** It includes activities, which can be executed during operation and that will not affect the object (component, equipment). This include inspecting various components of the wind energy system using condition-based monitoring (CBM). The condition monitoring could be used to get a constant monitoring of various subsystems (II) **Direct preventive maintenance.**	06 marks

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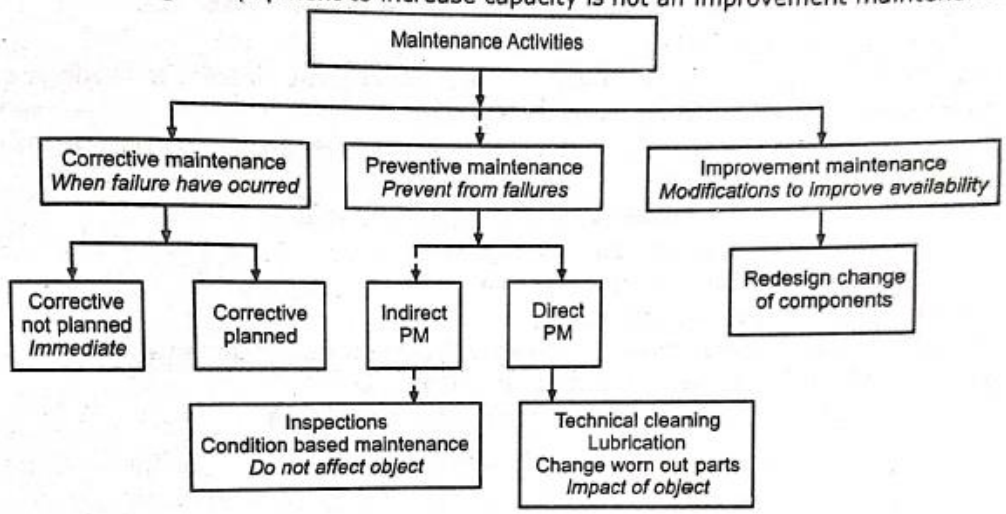
Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme

2. Improvement maintenance:

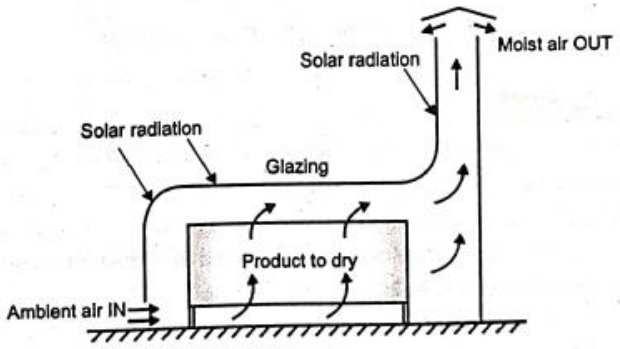
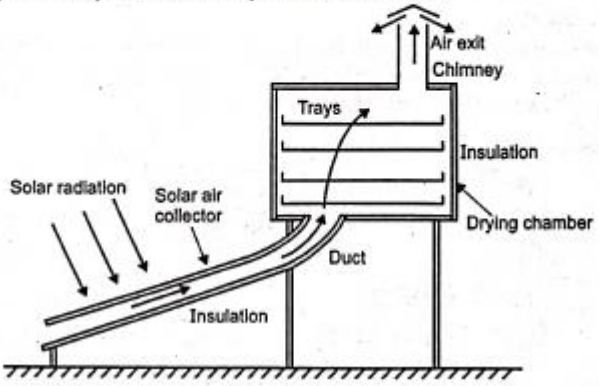
- Improvement maintenance is the program of initiatives taken to improve the operational reliability from a maintenance aspect.
- Reconditioning of equipment to increase capacity is not an improvement maintenance.



Wind turbine maintenance refers to the process of keeping wind turbines running smoothly. It includes routine inspections, cleaning, lubrication, and repairs. Wind turbine maintenance tasks include turbine inspection, turbine cleaning, turbine lubrication, and turbine repair.

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
6	a	**Solar dryer** 1. **Integrated solar dryer** 2. **Distributed solar dryer** **Integrated solar dryer** Integrated type solar energy dryer consists of a container insulated at its sides and covered with a single glazing or roof. The interior walls are blackened. Therefore, solar radiation transmitted though the cover is absorbed by the blackened interior surfaces as well as by the product, thus raising the internal temperature of the container. At the front, special openings provide ventilation, with warm air leaving via the upper opening under the action of buoyant forces.  **Distributed solar dryer** They can generally produce higher-quality products and are recommended for deep layer drying. Their disadvantages are that the fluctuation in the temperature of the air leaving the solar air collector makes constant operating conditions within the drying chamber difficult to maintain; they are relatively elaborate structures, requiring more capital investment in equipment; and they have higher running costs for maintenance than integral types. The efficiency of distributed type dryers can be easily increased, because the components of the unit can be designed for optimal efficiency of their functions.  	06 marks

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>6</td><td>b</td><td>
For environment friendly solution, the available energy renewable sources need to be examine on the basis of technical and economical aspects. Depending upon geographical location and availability of resources some solutions are possible. e.g. different combinations of renewable hybrid system includes solar, wind, diesel, battery etc.

Following procedure can be adapted for feasibility assessment,

1.Nature of load profile

First step is to prepare load profile and find maximum and average power consumption.

2.Choosing a suitable location(Site Selection)
<table>
<tr><td>Sr. No.</td><td>Graphical Feature</td><td>Type of plants</td></tr>
<tr><td>1</td><td>High altitude mountain valley</td><td>Solar-Biomass</td></tr>
<tr><td>2.</td><td>Plain Plateau, rural areas</td><td>Biomass-Wind</td></tr>
<tr><td>3.</td><td>Semi-dessert and Dessert, Costal regions</td><td>Solar-Wind</td></tr>
</table>
3.Exploring availability of that resources at that location: Information related to long term availability of all possible RES. e.g. wind speed, solar radiation, biomass availability should be gather

4.Modelling the hybrid system based on the resources and cost.

There are several commercial and free software available to analyze feasibility of power generation system e.g. RETscreen, HOMER, iHOGA and hybrid tool

5. Hybrid optimization model for electric renewable optimization tool of USA base is largely used.

6. The reliability impact on total cost function could be investigated. Socio –environmental benefits of various electricity generations could be estimated and taken in to consideration before coming into final conclusion.
</td><td>06 marks</td></tr>
</table>

SUMMER – 2022 EXAMINATION

Subject Name: Renewable Energy Sources **Model Answer** Subject Code: 22661

Q. No.	Sub Q. N.	Answer	Marking Scheme
	c	**Installation of Typical Biogas Plant** 1.Dimensions marking 2. Excavation works 3.Preparation of the digester's bottom 4.Building the Digester 5.Integrating the heating tubes 6.Building the gas holder 7.Technology Installation 8.Installing the insulation 9.Gas processing unit 10.Mixing technology 11.Solid feeder 12.Biogas storage 13.Cover membrane 14.Monitoring and controlling 15.Digested substrate storage **Maintenance procedure of Typical Biogas Plant** 1.Removal of sediments in the digester 2.Measures against foam layers 3. Clean and lubricate the primary gas valve. 4. Clean or repair gas lamp 5. Clean and repair water drain overflow. 6. Repair pipeline to stop leakages 7. Clean stoves. 8. Replace the rubber hose. 9.Any sealant, gasket or fastener used in tank construction needs to be properly evaluated to ensure long service life	06 marks

22661

12223

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

Marks

1. Attempt any FIVE of the following : **10**

(a) Classify energy sources.

(b) State applications of biofuels.

(c) Enlist the types of panels.

(d) Write specification of HAWT.

(e) Name any four components of Micro-Hydro Power System.

(f) Write merits of PV cells.

(g) Name any four hybrid systems.

2. Attempt any THREE of the following : **12**

(a) Distinguish between Renewable and Non-renewable energy sources.

(b) State the types of Solar Photovoltaic system and explain with the help of schematic diagram.

(c) Draw basic structure of Horizontal axis wind mill and name the components.

(d) Explain micro hydel plant.

3. Attempt any THREE of the following : **12**

(a) Explain working of solar dryer with neat sketch.

(b) Explain stand alone street light system.

(c) Describe the working of fixed dome type biogas plant with neat sketch.

(d) Define biomass & biomass energy. Discuss various biomass resources.

4. Attempt any THREE of the following : **12**

(a) Explain the working of wind solar hybrid system.

(b) Differentiate between HAWT & VAWT.

(c) Explain working of propeller type reaction turbine.

(d) Discuss in detail the preventive maintenance of Hydro power plant and why preventive maintenance is necessary ?

(e) Explain solar biogas hybrid system with neat sketch.

5. Attempt any TWO of the following : **12**

(a) Explain with neat sketch construction and working of flat plate collector.

(b) Explain the installation procedure for Solar roof Top system.

(c) Write in detail the maintenance procedure of large horizontal axis wind turbine.

6. Attempt any TWO of the following : **12**

(a) How the solar dryers are classified and explain any one with neat sketch.

(b) Discuss the technical and commercial feasibility in brief for renewable energy system.

(c) Describe the installation & maintenance procedure of a typical Biogas plant.
