WINTER– 18 EXAMINATION

Subject Name: TOM **Model Answer** Subject Code: 17412

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. No.	Answer	Marking Scheme
1.A		**Attempt any SIX**	
	a)	Higher pair. When the two elements of a pair have a line or point contact when relative motion takes place, the pair is known as higher pair. Toothed gearing, ball and roller bearings and cam and follower are the examples of higher pairs.	1 M each
	b)	Sliding pair, Turning pair, Rolling pair, Screw pair or helical pair, spherical pair (Any four)	½ M each
	c)	**Fluctuations of energy :** The variations of energy above and below the mean resisting torque line are called fluctuations of energy. **Coefficient of fluctuations of energy:** It may be defined as the ratio of the maximum fluctuation of energy to the work done per cycle.	1 M each
	d)	**Slip:** The forward motion of the driver without carrying the belt with it or forward motion of the belt without carrying the driven pulley with it, is called slip of the belt. **Creep:** When the belt passes from the slack side to the tight side, a certain portion of the belt extends and it contracts again when the belt passes from the tight side to slack side. Due to these changes of length, there is a relative motion between the belt and the pulley surfaces. This relative motion is termed as creep.	1 M each
	e)	A flywheel used in machines serves as a reservoir, which stores energy during the period when the supply of energy is more than the requirement, and releases it during the period when the requirement of energy is more than the supply. In case of internal combustion engines the energy is developed during one stroke (power/ expansion) and the engine is to run for the whole cycle on the energy produced during this one stroke. So, flywheel is necessary.	

	f)	The high speed of engines and other machines is a common phenomenon now-a-days. It is, therefore, very essential that all the rotating and reciprocating parts should be completely balanced as far as possible. If these parts are not properly balanced, the dynamic forces are set up. These forces not only increase the loads on bearings and stresses in the various members, but also produce unpleasant and even dangerous vibrations. Thus, balancing is very necessary.	
	g)	Advantages of Roller follower over knife edge :- i) Working is smooth due to rolling motion ii) There is no noise in operation iii) Life is more iv) Due to rolling action it results in more accuracy and reliability	
	h)	Applications of Single plate clutch: Trucks and Buses Multi-plate clutch: Two wheeler geared vehicles	
1.B		**Attempt any TWO**	
	a)	Classification of Brakes :- The brakes, according to the means used for transforming the energy by the braking elements, are classified as : 1. Hydraulic brakes 2. Electric brakes 3. Mechanical brakes. 4. Air / Vacuum Brakes. The mechanical brakes may be divided into the following two groups : Radial brakes and Axial brakes The radial brakes may be sub-divided into External brakes and Internal brakes. According to the shape of the friction elements, these brakes may be Block or Shoe brakes and Band brakes.	
	b)	**Difference between Flywheel and Governor**	

S.N.	Flywheel	Governor
1	The flywheel stores the energy and gives up the energy whenever required during cycle.	It regulates the speed by regulating the quantity of charge (fluid) of prime mover.
2	It has no control over the quantity of working fluid.	Governor takes care of quantity of working fluid.
3	It works continuously from cycle to cycle	It works intermittently, i.e. only when there is change in load
4	It regulates the speed during one cycle only.	It regulates the speed over period of time.
5	It take care of fluctuation of speed during thermodynmic cycle	It take care of fluctuation of speed during variation of load
6	It is used in toys, IC engine, hand watches, press, punching and shear machines,	It is used in turbines and engines

	c)	Problem on Belt:- d = 60mm = 0.06m T1 = 2500 N $\theta = 180^{o}$ = 3.14 rad $N = 200$ r.p.m. ; $\mu = 0.25$ We know that velocity of the belt, $v = \frac{\pi d . N}{60} = \frac{\pi \times 0.06 \times 200}{60}$ = 0.628 m/s Let T_2 = Tension in the slack side of the belt. We know that $\frac{T_1}{T_2} = e^{\mu\theta}$ = 2.19 P = (T1 - T2) x V = (2500 - 1141.5) x 0.628 = 853.57 watt = 0.853 kW	
Q.2		**Solve any FOUR**	
	a)	**Angular Velocity :-** The rate of change of angular displacement is known as Angular Velocity. It is denoted as ω. **Absolute Velocity :-** Velocity of any point on a link with respect to another fixed point on the mechanism is known as Absolute Velocity. It is denoted as V_A or V_B or V_P etc. **Relative Velocity :-** Velocity of any point on a link with respect to another moving point on the mechanism is known as Relative Velocity. It is denoted as V_{AB} or V_{BC} or V_{PQ} etc. **Angular Acceleration:-** The rate of change of angular velocity is known as Angular Acceleration. It is denoted as α	1 M each

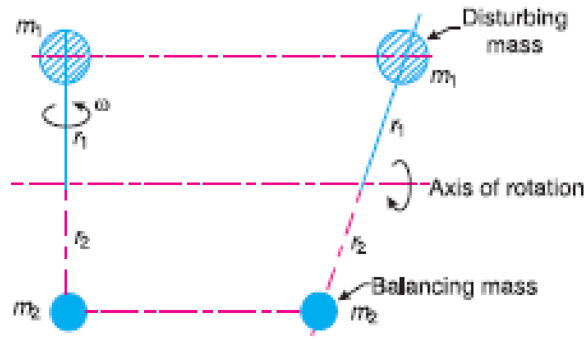
b)

Consider a disturbing mass m_1 attached to a shaft rotating at ω rad/s as shown in Fig. Let r_1 be the radius of rotation of the mass m_1 (*i.e.* distance between the axis of rotation of the shaft and the centre of gravity of the mass m_1).

We know that the centrifugal force exerted by the mass m_1 on the shaft,

$$F_{C1} = m_1 \cdot \omega^2 \cdot r_1 \quad \ldots (i)$$

This centrifugal force acts radially outwards and thus produces bending moment on the shaft. In order to counteract the effect of this force, a balancing mass (m_2) may be attached in the same plane of rotation as that of disturbing mass (m_1) such that the centrifugal forces due to the two masses are equal and opposite.



Balancing of a single rotating mass by a single mass rotating in the same plane.

Let r_2 = Radius of rotation of the balancing mass m_2 (*i.e.* distance between the axis of rotation of the shaft and the centre of gravity of mass m_2).

$\therefore$ Centrifugal force due to mass m_2,

$$F_{C2} = m_2 \cdot \omega^2 \cdot r_2 \quad \ldots (ii)$$

Equating equations (*i*) and (*ii*),

$$m_1 . \omega^2 \cdot r_1 = m_2 \cdot \omega^2 \cdot r_2 \quad \text{or} \quad m_1 \cdot r_1 = m_2 \cdot r_2$$

C

Inversion

The method of obtaining different mechanisms by fixing different links in a kinematic chain, is known as inversion of the mechanism.

Inversions of Four Bar Chain

1. Beam engine (crank and lever mechanism).
2. Coupling rod of a locomotive (Double crank mechanism).
3. Watt's indicator mechanism (Double lever mechanism).

1 M each

d

Difference Between structure and machine:-

Sr.	Structure	Machine
1	The member of structure do not move relative to one other	The part of machine move relative to one anot
2	Structure Do not transform energy in to the useful work	Machine Transform available energy into usefu
3	The member of structure transmit forces only	The link of m/c made transmit both power relat motion and forces.
4	It has no mechanism	Machine can have one or more mechanism

1M each

		5	e,g: Railway Bridge, truss, Machine frames	e.g : Lathe m/c , Milling m/c, IC engine

	e	**Compare Cross and Open belt drives:-**	1M each

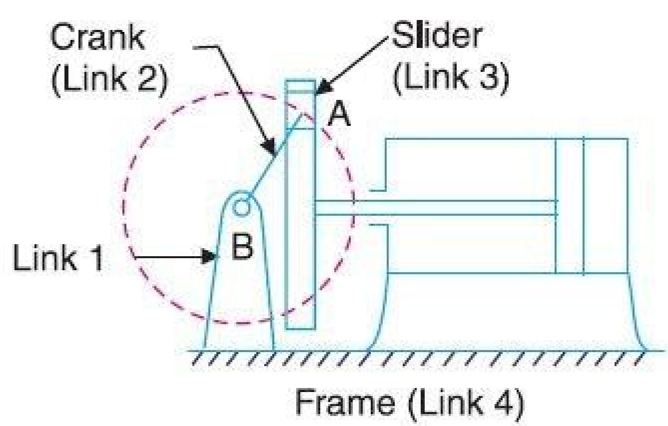
.	Basis	Cross Belt	Open Belt
1	VR	More	Less
2	Direction of Pulleys	Opposite	Same
3	Application	Lathe, Flour mill	Spindle Mould Machine, Circular Saw Machine, heavy Duty Treadmills
4	Length of Belt Drive	More	Less

f (2M each)

Roller follower:- Extensively used where more space is available such as in stationary gas and oil engines and aircraft engines.
Spherical faced follower:- Used in automobile engines
Radial or disc cam :- Used in Engines
Cylindrical cam:- Used in Clothing and weaving m/c
Fig shows Radial and Cylindrical Cams with Roller & Spherical Followers

3 **Attempt any FOUR**

a. (2M each)



Scotch yoke mechanism.

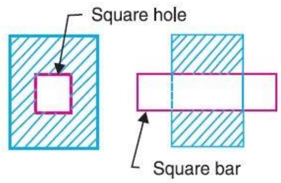
Working:- This mechanism is used for converting rotary motion into a reciprocating motion. The inversion is obtained by fixing either the link 1 or link 3. In Fig. 5.35, link 1 is fixed. In this mechanism, when the link 2 (which corresponds to crank) rotates about B as centre, the link 4 (which corresponds to a frame) reciprocates. The fixed link 1 guides the frame.

b.

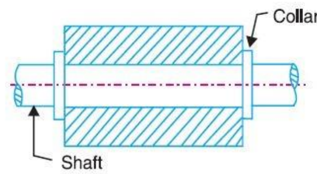
1.Completely constrained motion:- When the motion between a pair is limited to a definite
direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion.

2 M each

Any one diagram



Square bar in a square hole.

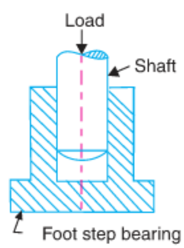


Shaft with collars in a circular hole.

Examples:

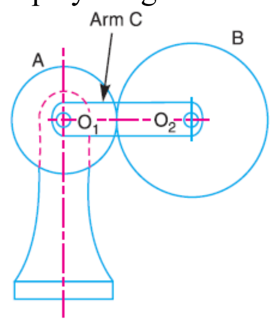
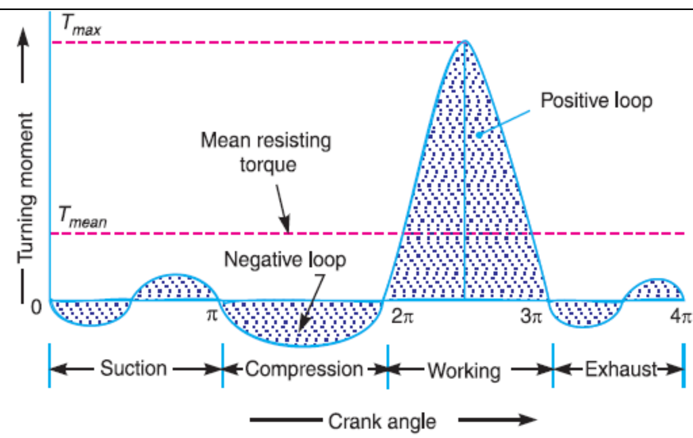
1. The motion of a square bar in a square hole
2. the motion of a shaft with collars at each end in a circular hole,

2. Successfully constrained motion:- When the motion between the elements, forming a pair, is such that the constrained motion is not completed by itself, but by some other means, then the motion is said to be successfully constrained motion. Consider a shaft in a foot-step bearing as shown in Fig. The shaft may rotate in a bearing or it may move upwards. This is a case of incompletely con-strained motion. But if the load is placed on the shaft to prevent axial upward movement of the shaft, then the motion of the pair is said to be successfully constrained motion.



Shaft in a foot step bearing.

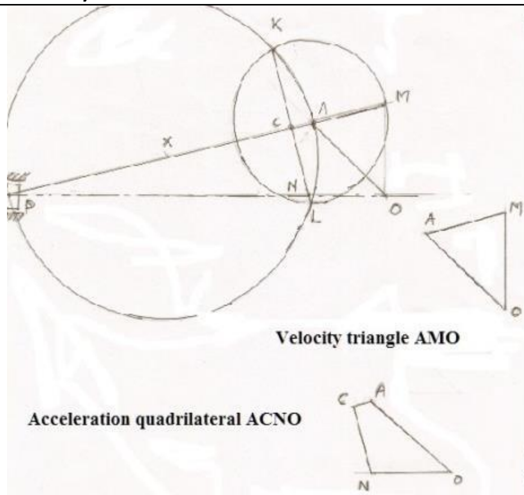
Examples:1. The motion of an I.C. engine valve (these are kept on their seat by a spring)
2. The piston reciprocating inside an engine cylinder
3. Shaft in a foot step bearing

	c.)	**Epicyclic gear train:-** A simple epicyclic gear train is shown in Fig. where a gear A and the arm C have a common axis at O1 about which they can rotate. The gear B meshes with gear A and has its axis on the arm at O2, about which the gear B can rotate. If the arm is fixed, the gear train is simple and gear A can drive gear B or vice- versa, but if gear A is fixed and the arm is rotated about the axis of gear A (i.e. O1), then the gear B is forced to rotate upon and around gear A. Such a motion is called epicyclic and the gear trains arranged in such a manner that one or more of their members move upon and around another member is known epicyclic grae train.  Epicyclic gear train.	**Working – 2 M** **Fig.- 2 M**
	d)	**Advantages of chain drive over belt drive (Any Four points)** 1. As no slip takes place during chain drive, hence perfect velocity ratio is obtained. 2. Since the chains are made of metal, therefore they occupy less space in width than a belt or rope drive. 3. The chain drives may be used when the distance between the shafts is less. 4. The chain drive gives a high transmission efficiency (upto 98 per cent). 5. The chain drive gives less load on the shafts. 6. The chain drive has the ability of transmitting motion to several shafts by one chain only.	**1M each**
	e)	 Turning moment diagram for a four stroke cycle internal combustion engine. **Significance of Turning Moment Diagram:-** 1. It shows variation of Turning moment with respect to crank angle of an Engine. 2. The variation of Torque indicates the size of Flywheel 3. More variation indicates Larger Flywheel and vice-a -versa. 4. Single curve variation is indication of single cylinder engine. 5. More than one curve indicates Multi cylinder engine.	**02 M** **02 M**

6. Area below and above of mean torque line indicated requirement of power or generation of power during that angle.

Above points can be well understood and explained by Turning moment diagram and we can design the proper flywheel for the engine for reducing speed variation of crank during each cycle.

f)



Velocity triangle AMO

Acceleration quadrilateral ACNO

klein's construction

1) Draw the basic diagram with the angle made by crank , crank (AO) and connecting rod (AP) with dimensions and scale.
2) Extend the connecting rod upto the vertical line of the crank circle and mark intersection point M, the triangle created ΔOAM is the velocity triangle.
3) Bisect the connecting rod at X.
4) Draw the circle with radius equal to XA or XB.
5) Draw the circle with Centre as "A" and radius equal to AM.
6) Both circles will intersect each other at two points (K, L), join these two points.
7) This line will intersect the connecting rod at point "C" and line of stroke at point "N".

Quadrilateral OACN is the acceleration diagram. This is required acceleration diagram of the links

If ωAO is the angular velocity of the crank, then

Linear velocity's of the links is given by-

VAO = ωAO x AO, VAP = ωAO x AM, VPO = ωAO x MO

Acceleration of the links is given by-

arAO = ω2AO x AO, arAP = ω2AO x AC, atAP = ω2AO x CN, aPO = ω2AO x NO

4 **Attempt any FOUR**

a)

i) Centrifugal Tension:- Since the belt continuously runs over the pulleys, therefore, some centrifugal force is caused, whose effect is to increase the tension on both, tight as well as the slack sides. The tension caused by centrifugal force is called centrifugal tension **01 M each**

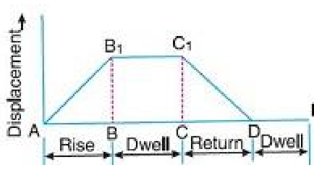
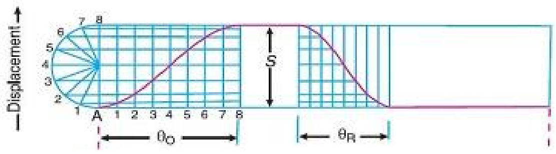
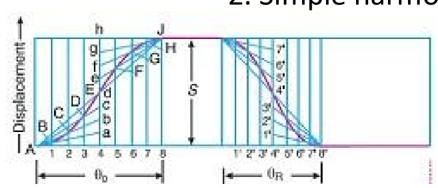
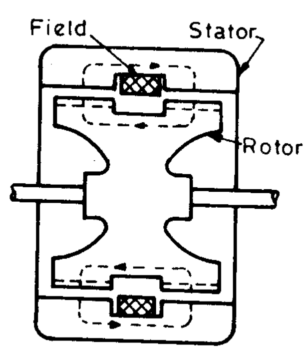
ii) Initial Tension:- When the pulleys are stationary and the belt is tightened up to get frictional grip ,the belt is subjected to some tension, which is called as called initial tension.

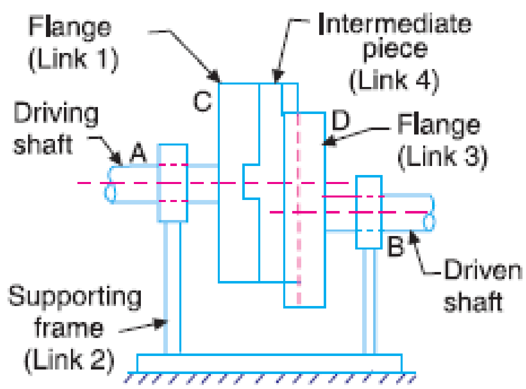
ii)Formulae for Initial Tension:-

$$T_0 = \frac{T_1 + T_2}{2} \quad \text{...(Neglecting centrifugal tension)}$$

$$= \frac{T_1 + T_2 + 2T_C}{2} \quad \text{...(Considering centrifugal tension)}$$

iv) Condition for Maximum Power Transmission :

		1. for maximum power, $T_C = \frac{T}{3}$. $T_1 = T - \frac{T}{3} = \frac{2T}{3}$ 2. velocity of the belt for the maximum power, $v = \sqrt{\frac{T}{3m}}$	
	b)	**Following are the important follower motions.** 1. Uniform velocity 2. Simple harmonic motion 3. Uniform acceleration and retardation.  1. Uniform velocity  2. Simple harmonic motion  3. Uniform acceleration and retardation.	**Types 01 M** **Dia. 01 M Each**
	c)	**Eddy Current Dynamometer** : It consists of a stator on which are fitted a number of electromagnets and a rotor disc made of copper or steel and coupled to the output shaft of the engine. When the rotor rotates, eddy currents are produced in the stator due to magnetic flux set up by the passage of field current in the electromagnets. These eddy currents oppose the motion of the rotor thus loading the engine. The eddy currents are dissipated in producing heat so that this type of dynamometer also requires some cooling arrangements. The torque is measured similar to absorption dynamometers i.e. with the help of moment arm. The load is controlled by regulating the current in the electromagnets.  Eddy current dynamometer.	**02 M** **02 M**

	d)	**Oldham's Coupling :-**  In Oldham's coupling as shown in figure the link 1 and link 3 are known as flanges. These flanges have diametrical slots cut in their inner faces. The intermediate piece (link 4) which is a circular disc have two tongues (*i.e.* diametrical projections) *T*1 and *T*2 on each face at right angles to each other. The tongues on the link 4 closely fit into the slots in the two flanges (link 1 and link 3). when the power is transmitted from shaft A to shaft B ,The intermediate piece (link 4) slides or reciprocate in the slots in the flanges. As it reciprocates it becomes just like two sliders sliding in flanges, so it is a inversion of double slider crank chain.	**01 M** **03 M**

e)

Que:- (4) e Given Data:-

$m_1 = 260 kg$, $r_1 = 0.3 m$ $\theta_1 = 0$

$m_2 = 160 kg$, $r_2 = 0.25 m$ $\theta_2 = 45^\circ$

$m_3 = 300 kg$, $r_3 = 0.15 m$ $\theta_3 = 135^\circ$

$m_4 = 200 kg$, $r_4 = 0.2 m$ $\theta_4 = 270^\circ$

Radius of Balancing mass $(r) = 0.2 m$

Space Diagram

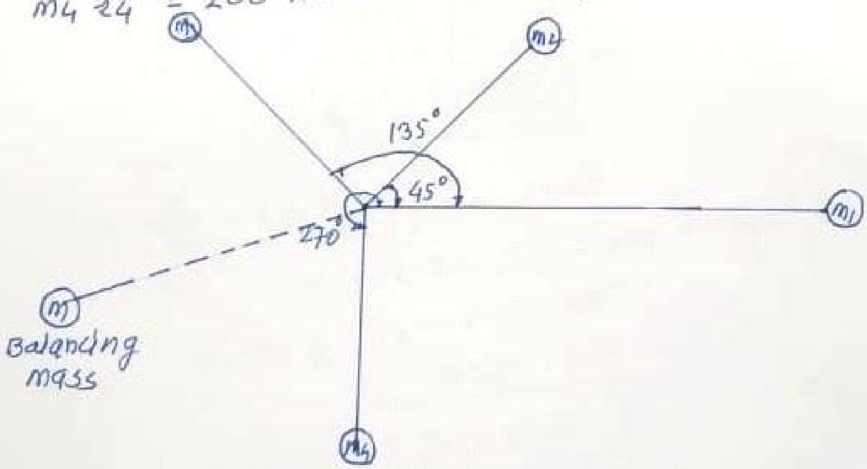
centrifugal force of mass :-

$m_1 r_1 = 260 \times 0.3 = 78 kg \cdot m$

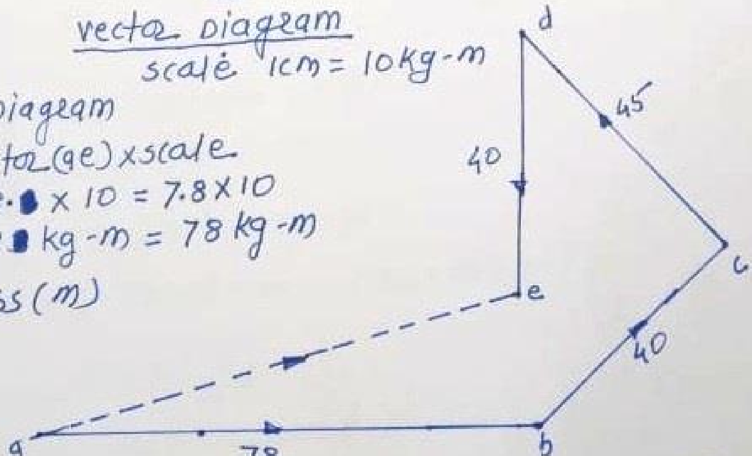
$m_2 r_2 = 160 \times 0.25 = 40 kg \cdot m$

$m_3 r_3 = 300 \times 0.15 = 45 kg \cdot m$

$m_4 r_4 = 200 \times 0.2 = 40 kg \cdot m$



Vector Diagram
scale 1cm = 10kg-m



From vector Diagram

Resultant = vector (ae) x scale
$= 7.8 \times 10 = 7.8 \times 10$

$R = 78 kg\text{-}m = 78 kg\text{-}m$

∴ Balancing mass (m)

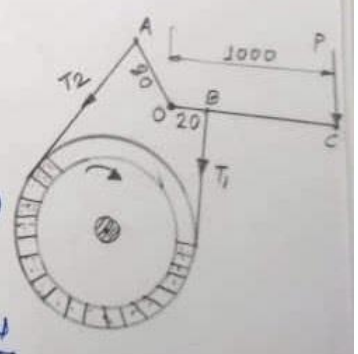
$\therefore R = m \times r$

$78 = m \times 0.2$

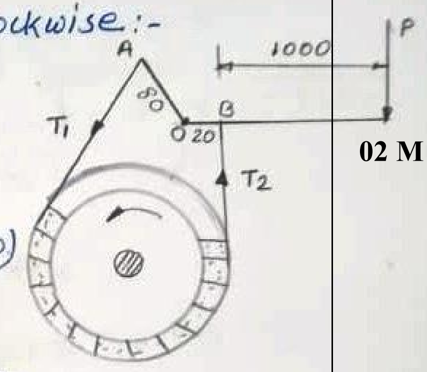
$\therefore m = 78/0.2$

$m = 390 kg$

Angle of Balancing mass $(\theta) = 198^\circ$

	f)	**1. Pitch point** :- It is a common point of contact between two pitch circles.. **2. Circular pitch (Pc)** :- It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth. **3. Clearance** :- It is the radial distance from the top of the tooth to the bottom of the tooth, in a meshing gear. **4. Backlash** :-It is the difference between the tooth space and the tooth thickness, as measured along the pitch circle.	01 M each
5		**Attempt any TWO**	
	a)	Que:- (5) (a) Given Data:- $n = 12$, $2\theta = 14°$ $\therefore \theta = 7°$, $d = 1.05\ m$, $r = 0.525\ m$, $t = 5cm = 0.05\ m$, $\mu = 0.35$, $l = 1m$, $T_b = 5000\ N\text{-}m$ Solution :- Diameter of Band $D = d + 2t$ $= 1.05 + (2 \times 0.05)$ $D = 1.15\ m$ $r = 0.575\ m$ Maximum Braking Torque $T_b = (T_1 - T_2) \times$ $5000 = (T_1 - T_2) \times 0.575$ $\therefore T_1 - T_2 = 8695.65\ N$ ..... (1)	01 M
		For Band and block brake, we know that $\frac{T_1}{T_2} = \left[\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}\right]^n$ $= \left[\frac{1 + 0.35 \times \tan(7°)}{1 - 0.35 \times \tan(7°)}\right]^{12}$ $\therefore \frac{T_1}{T_2} = \left(\frac{1.043}{0.957}\right)^{12} = 2.80$	01 M
		$T_1 = 2.80\ T_2$ — put in eqn (1) $2.80\ T_2 - T_2 = 8695.65$ $\therefore T_2 = 4830.9\ N$	01 M
		$\therefore T_1 = 2.80 \times 4830.9$ $T_1 = 13.52 \times 10^3\ N$ (1) Assuming Drum rotates clockwise :- Taking moment @ O Fulcrum point	01 M
		$P \times 1000 = (T_2 \times 80) - (T_1 \times 20)$ $P \times 1000 = (4830.9 \times 80) - (13.5 \times 10^3 \times 20)$ $\therefore P = 116.47\ N$ $\therefore$ Minimum Force required $P = 116.47\ N$  	02 M

② Assuming Drum rotates Anticlockwise :-



Taking moment @ O Fulcrum

$P \times 1000 = (T_1 \times 80) - (T_2 \times 20)$

$P \times 1000 = (13.52 \times 10^3 \times 80) - (4830.9 \times 20)$

$P = 984.98 N$

∴ Minimum force required = P = 984.98 N.

02 M

b)

Que :- ⑤ b

Given data :-

Radius of crank (r) = 40 mm = 0.04 m

Length of connecting rod (l) = 160 mm = 0.16 m

Angular velocity (ω) = 20 rad/sec .

Angle of crank (θ) = 45°. $n = \frac{l}{r} = \frac{160}{40} = 4$

Solution :- Analytical Method :-

① velocity of piston $(V_B) = \omega r \left(\sin\theta + \frac{\sin 2\theta}{2n}\right)$

$= 20 \times 0.04 \left(\sin 45 + \frac{\sin(2\times45)}{2\times4}\right)$

$V_B = 0.66$ m/sec **02 M**

② Acceleration of piston $(a_P) = \omega^2 r \left[\cos\theta + \frac{\cos 2\theta}{n}\right]$ **02 M**

$= 20^2 \times 0.04 \left(\cos 45^\circ + \frac{\cos 90^\circ}{4}\right)$

$a_B = 11.31$ m/sec²

③ Angular velocity of connecting Rod :-

$\omega_{AB} = \frac{\omega \cos\theta}{n}$

$= \frac{20 \times \cos 45^\circ}{4}$ **02 M**

$\omega_{AB} = 3.53$ rad/sec

④ Angular acceleration of connecting Rod :-

$\alpha_{AB} = \frac{\omega^2 \sin\theta}{n} = \frac{(20)^2 \times \sin 45^\circ}{4}$ **02 M**

$\alpha_{AB} = 70.71$ rad/sec²

NOTE :- As it is not mentioned to solve by Analytically or Graphically. If students solve by graphically and answers are correct marks should be given in same manner.

c)

Que:- (5) c

Given Data:-

$P = 55\,kW = 55 \times 10^3$ watts, $N = 1800$ rpm, $\mu = 0.1$.

$p = 160\,kN/mm^2 = 160 \times 10^3\,N/mm^2$, $r_2 = 80$ mm,

$r_1 = 114.28$ mm, $n = ?$

Solution :- Angular velocity $(\omega) = \frac{2\pi N}{60} = \frac{2 \times \pi \times 1800}{60}$

$\omega = 188.49$ rad/sec.

Power Transmitted $(P) = T \times \omega$

$55 \times 10^3 = T \times 188.49$

$\therefore T = 291.79$ N-m $= 291.79 \times 10^3$ N-mm. **02 M**

Since the intensity of pressure is maximum at inner radius r_2 therefore

$p \cdot r_2 = C$

$160 \times 10^3 \times 80 = C$

$\therefore C = 12.8 \times 10^6$ N/mm **02 M**

Axial Force required to engage the clutch,

$W = 2\pi C (r_1 - r_2)$

$W = 2 \times \pi \times 12.8 \times 10^6 (114.28 - 80)$

$W = 2.75 \times 10^9$ N

Mean Radius of friction surface

$R = \frac{r_1 + r_2}{2} = \frac{114.28 + 80}{2} = 97.14$ mm **02 M**

$R = 0.09714$ m

$\therefore$ Torque transmitted (T)

$T = n \cdot \mu \cdot W \cdot R$

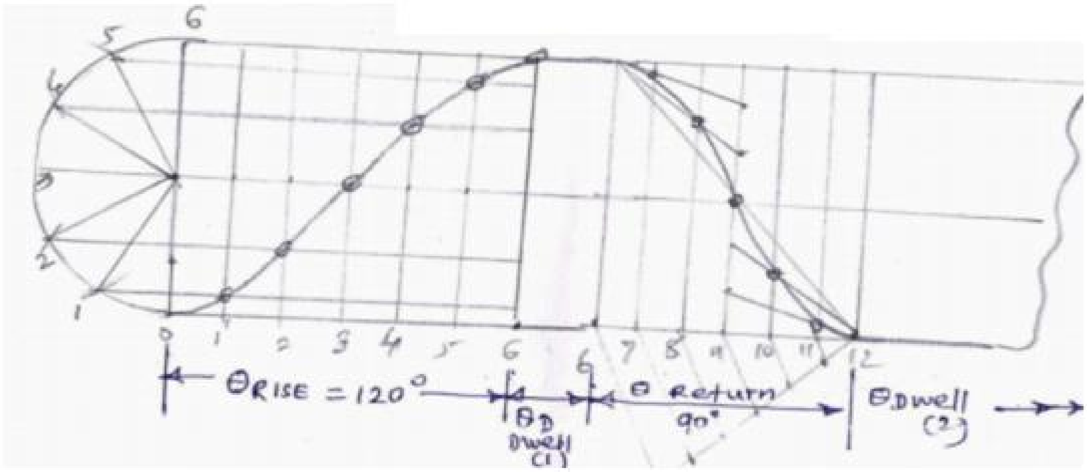
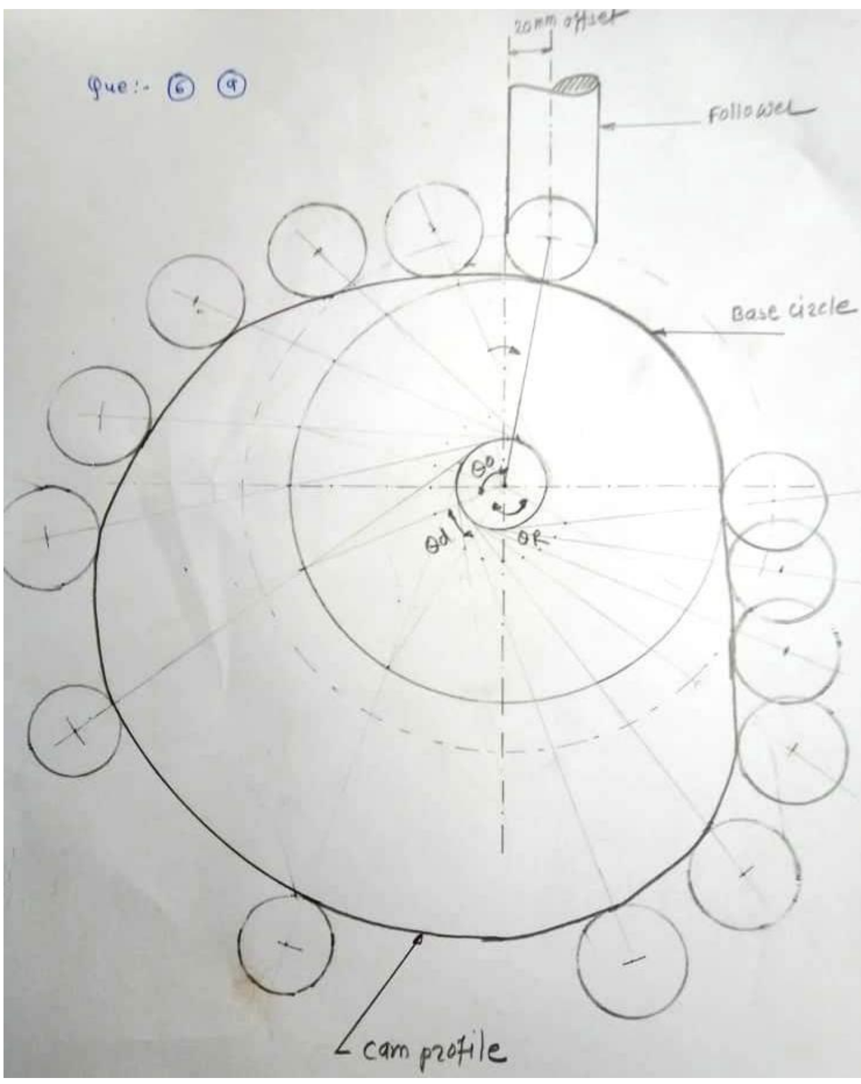
$291.79 \times$ [illegible] $= n \times 0.1 \times 2.75 \times 10^9 \times 0.09714$

$291.79 \times$ [illegible] $= n \times 26.71 \times 10^6$

$\therefore n =$ ~~0.0109~~ Not Feasible.

$n = 1.09 \times 10^{-5}$ – Not feasible **02 M**

I think Intensity of pressure is incorrect (It should be 0.160 N/mm²)

6		**Attempt any TWO**	
	a)	 	03 M 05 M

b)

$W = 15\ kN$, $N = 100\ rpm$, $r = 7.5\ cm = 0.075\ m$

(i) Considering uniform pressure theory

Torque, $T = \frac{2}{3} \mu W R\ N\text{-}m$

$= \frac{2}{3} \times 0.05 \times 15 \times 10^3 \times 0.075$

$= 37.5\ Nm$ ..... [2M]

Power lost,

$P = \frac{2\pi N T}{60 \times 1000} = 0.393\ kW$ ... [2M]

(ii) Considering uniform wear theory

Torque, $T = \frac{1}{2} \mu W R\ N\text{-}m$

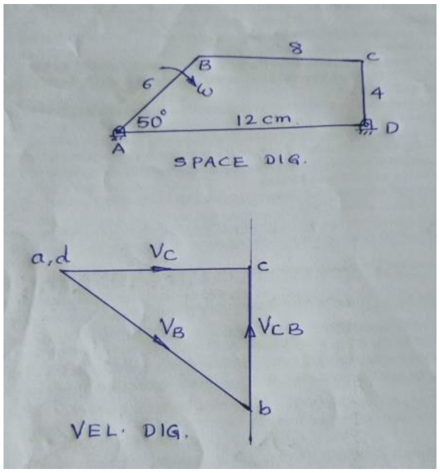
$= \frac{1}{2} \times 0.05 \times 15 \times 10^3 \times 0.075$

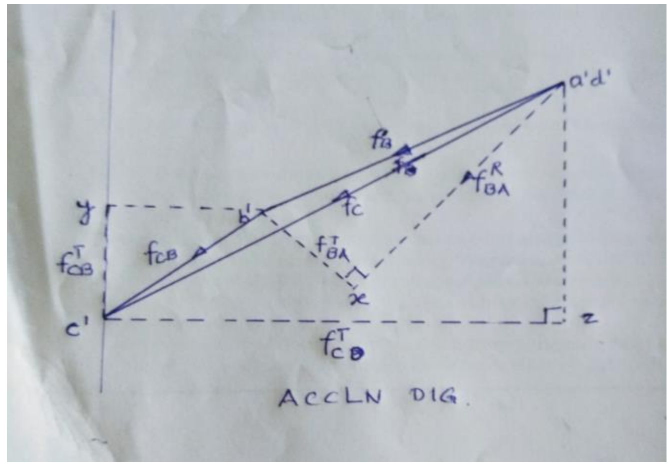
$= 28.1\ N\text{-}m$ ... [2M]

Power lost,

$P = \frac{2\pi N T}{60 \times 1000} = 0.294\ kW$ ... [2M]

c)





Each Dia. 02 M

$V_{BA} = V_B = r\omega = 0.06 \times 100$
$= 6$ m/s

From velocity diagram

$V_{CD} = V_C = 4.5$ m/s and

$V_{CB} = 4$ m/s

$\therefore \omega_{CD} = 4.5/0.04 = 112$ rad/s ....Ans

& $\omega_{BC} = 4/0.08 = 50$ rad/s ....Ans

02 M

Acceleration:

$f^R_{BA} = f^R_B = \frac{(6)^2}{0.06} = 600$ m/s^2

$f^T_{BA} = AB \times 4000 = 240$ m/s^2

$f^R_{CB} = 300$ m/s^2 & $f^R_{CD} = 506.2$ m/s^2

From Accln diag.

$f^T_{CB} = 240$ m/s^2 & $f^T_{CD} = 850$ m/s^2

$\therefore \alpha_{CB} = \frac{240}{0.08} = 3000$ rad/s^2 and---Ans

$\alpha_{CD} = \frac{850}{0.04} = 21250$ rad/s^2 ... Ans.
