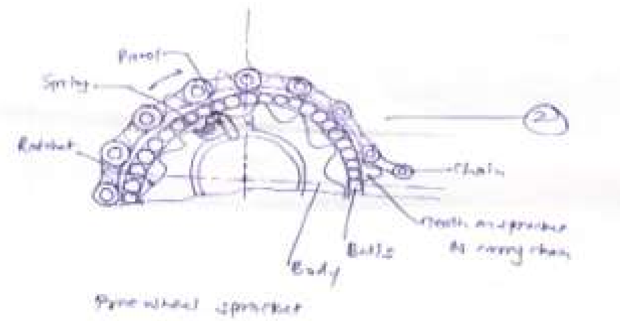
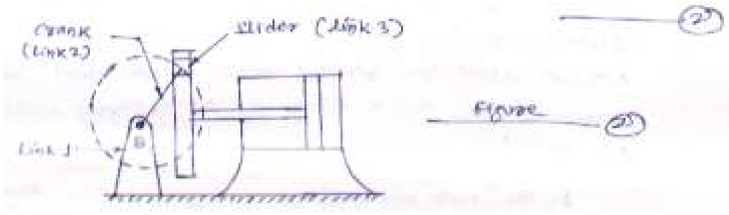
WINTER – 12 EXAMINATION

Subject Code :- 12089 **Model Answer**

Q.1.A.	**Any SIX (6 x 2)**	**12**
a.	Define kinematic link and kinematic chain. Kinematic link:- A kinematic link is a resistant body which constitute part of machine and which has relative motion to some other part of machine. Kinematic chain:- When the kinematic parts are coupled in such a way that the lost link joined to the first link to transmit definite motion.	 **1** **1**
b.	List types of kinematic pair on the basis of relative motion -sliding pair, turning pair, rolling, screw, spherical. **(any 4 ½ each)**	
c.	Define completely constrained motion and successfully constrained motion. Completely constrained motion:- when the motion between a pair is limited to a definite direction irrespective of the direction of force applied. 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.	 **1** **1**
d.	List the kinematic pairs in single slider crank chain One sliding pair –crosshead & frame Three turning pair – frame & crank, crank & conn. rod, conn. rod & cross head	**1** **1**
e.	Define prime circle and pressure angle Prime circle:- It is the smallest circle that can be drawn from the centre of the cam and tangent to the pitch curve. Pressure angle:- It is the angle between the direction of the follower motion and normal to the pitch curve.	 **1** **1**
f.	State two advantages of roller follower over knife edge follower. i) Rate of wear is greatly reduced. ii)Extensively used where more space is available.	 **1** **1**
g.	Define i) Slip and ii) Creep of belt i) Slip:- In case of belt drive the frictional grip between belt and pulley is not sufficient. Due to this there is forward motion of driver, pulley without carrying belt. ii) Creep:- when the belt passes from the slack side to the tight side, a certain portion of the belt extends & 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.	 **1** **1**
h.	State the terms used in vibration Time period, cycle, frequency	**2**
B.	**Any TWO (2 x 4)**	**8**
a.	**Explanation – 2, Sketch – 2** It is a toothed wheel engaging with a chain that transmits motion form one wheel to another wheel in either direction. Application of force on pedal transmits the motion through chain to the rear wheel. The chain engages with the teeth of front and rear wheel sprocket. It is a sprocket in which is inner mechanism works in order to provide the clockwise positive motion to the wheel during forward pedaling of bicycle and counter clockwise freewheeling motion of wheel during reverse pedaling of bicycle.  	

b.	**Explain the working of scotch yoke mechanism with neat sketch.**	

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 figure link 1 is fixed. In this mechanism, when the link 2 rotates about B as centre, the link 4 reciprocates. The fixed link 1 guides the frame. **2**



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c. Distinguish machine and structure on the basis of i) Motion ii) Type of energy transferred iii) Mechanism iv) Application. **1 each**

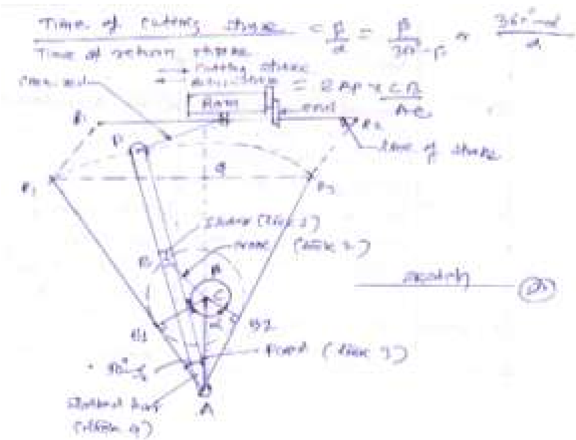
	Machine	Structure
i) Motion	Relative motion exists between two or more parts of machines simultaneously with respect to one another	i) No relative motion exists between two members (links) of structure.
ii)	Transformation of both forces and motion. It transforms the available energy into useful work.	ii) No transformation of energy into useful work (only forces are transformed)
iii)	Links of machine are meant to transmit motion & forces which are dynamic	iii) Member of structure are meant for carrying loads or subject to forces having straining action.
iv) Application	Screw jack, engine lathe, prime mover etc.	Building, bridges, roof trusses machine frame etc.

Q.2. Any FOUR (4 x 4) **16**

a. **Draw a neat sketch of crank & slotted lever quick return mechanism and explain its working.**

In this mechanism, the link AC forming the turning pair is fixed as shown in fig. The link 3 corresponds to the conn. Rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP & thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool & reciprocates along the line of stroke R_1R_2. **2**

In the extreme positions, AP_1 & AP_2 are tangential to the circle & the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB_1 to CB_2 in the clockwise direction. The return stroke occurs when the crank rotates from the position CB_2 to CB_1 in the clockwise direction.



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b.	**Define linear velocity, angular velocity, absolute velocity & state the relation between linear velocity and angular velocity.** Linear velocity:- Rate of change of linear displacement. Angular velocity:- Rate of change of angular displacement. Absolute velocity:- A body or object moves in a particular direction the motion of the body or object is referred to as absolute motion. Relation between linear velocity & angular velocity. V = rω V = linear velocity, r = Radius ω = Angular velocity	**1** **1** **1** **1**
c.	Given power P = 10 kw = 10 x 10^3 w Dia. Of pulley d = 0.8 m r = 0.4 m = 400 mm Speed N = 300 rpm Angle of lap $@ = 175^0 = 175 \times \frac{\pi^c}{180} = 3.05$ c.o.f. μ = 0.25 T_1 = …… T_2 = …… mass = 1.4 kg/m max. tension = T initial tension = Ti $V = \frac{\pi dN}{60} = \frac{\pi \times 0.8 \times 300}{60} = 12.56\ m/s$ $P = (T_1 - T_2) \times V$ $10 \times 10^3 = (T_1 - T_2) \times 12.56 =$ $\therefore T_1 - T_2 = 796.18$ $2.3 \log\left(\frac{T_1}{T_2}\right) = \mu\theta = 0.625 \times 175 \times \frac{\pi}{180} = 0.76$ $\frac{T_1}{T_2} = 2.15$ from equation i & ii $2.15\ T_2 - T_2 = 796.18$ $\therefore T_2 = 692.33\ N$ $\&\ T_1 = 2.15 \times T_2 = 1488.51\ N$ $Tc = mv^2 = 1.4 \times (12.56)^2 = 220.85$ max. tension $= 3 \times 220.85 = 662.56\ N$ initial tension $T0 = \frac{T_1 + T_2 + 2Tc}{2} = \frac{1488.51 + 692.33 + 2 \times 662.50}{2}$ $T0 = 1752.95\ N$	**1** **1** **1** **1**

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d.

Advantages

- i) Compact due to small distance between the centers of pulleys.
- ii) The drive is positive, because the slip between the belt & the pulley groove is negligible.
- iii) Operation of the belt and pulley is quite.
- iv) It provides longer life, 3 to 5 years.
- v) It can be easily install & removed.
- vi) The high V.R. may be obtained (any 4 – ½ each)

Disadvantages –

- i) It cannot be used with large centre distance.
- ii) V-belts are so durable as flat belts.
- iii) The construction of pulleys for V-belts is more complicated.
- iv) Not suitable for constant speed application (1/2 each)

e.

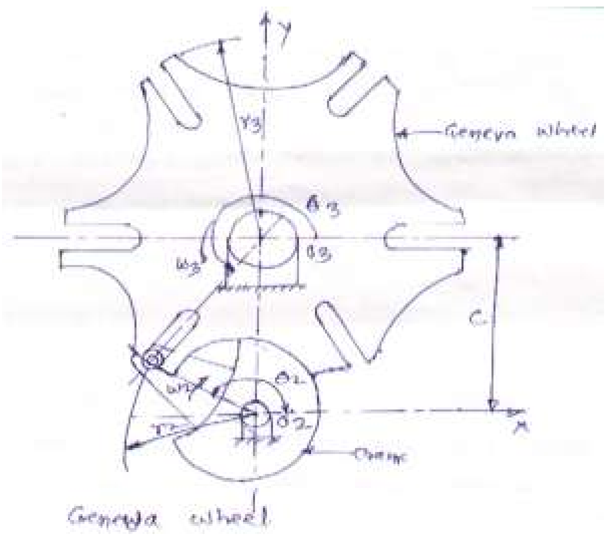
Distinguish flywheel and govemor (any 4 – 1 each)

Flywheel	Govemor
i) Control the speed variations caused by the fluctuations of the engine turning moment during each cycle of operation.	i) To regulate the speed of an engine automatically when there are variations in the load.
ii) It has no influence on mean speed of the prime mover.	ii) It has no influence over cyclic speed fluctuations.
iii) Mathematically a flywheel controls $\frac{\delta N}{\delta t}$	iii) It controls δN
iv) It is not essential element of every prime mover it is used only in case there are undesirable cyclic fluctuations of energy output or input.	iv) It is an essential element of every prime mover to meet the varying demand for power.

f.

Draw a sketch and explain working principle of Genera mechanism.

It is a camlike mechanism, which provides intermittent rotary motion and is widely used in both low and high-speed machinery. A drawing of a six slot genera mechanism is shown in figure. The centre line of the slot & crank are mutually perpendicular at engagement and dis-engagement. The crank which usually rotates at a uniform angular velocity, carries a roller to engage with the slots. During one revolution of the crank. The geneva wheel rotates a fractional part of revolution, the amount of which is dependent on the no of slots. The circular segment attached to the crank effectively locks the wheel against the rotation when the roller is not in engagement, and also position the wheel for correct engagement of roller with the next slot. **2**



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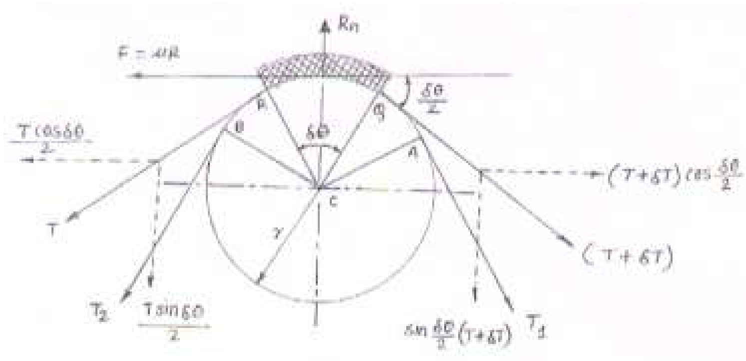
Q.3. a.



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Let T_1 = Tension on tight side of belt.
T_2 = Tension on slack side of belt.
R_n = Normal reaction of pulley on belt.
μ = Coefficient of friction between belt & pulley.
θ = Angle of contact in radians.

- Consider a small element strip of belt RQ. Subtending on angle δ θ at the center 'C' force acting on the element are T and T + δT on slack and tight sides respectively. Assuming a drive pulley rotating in clockwise direction.
- Resolving the forces horizontally.

$$F = (T + \delta T)\cos\frac{\delta\theta}{2} - T\cos\frac{\delta\theta}{2}$$

As $\delta\theta$ *is very small*

$$\cos\frac{\delta\theta}{2} = 1$$

and $F = \mu Rn$

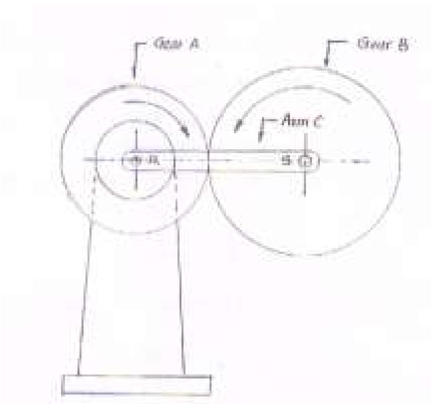
$$\mu Rn = (T + \delta T) - T = \delta T$$

$$Rn = \frac{\delta T}{\mu}$$

- Resolving Vertically,

	$Rn = (T+\delta T)\sin\frac{\delta\theta}{2} + T\sin\frac{\delta\theta}{2}$ $ds\ \delta\theta\ is\ very\ small,\ \sin\frac{\delta\theta}{2} = \frac{\delta\theta}{2}$ $Rn = (T+\delta T)\frac{\delta\theta}{2} + T\frac{\delta\theta}{2}$ $= T\frac{\delta\theta}{2} + \frac{\delta T\delta\theta}{2} + T\frac{\delta\theta}{2}$ $Negalting\ \frac{\delta T\delta\theta}{2}$ $Tn = T\frac{\delta\theta}{2} + T\frac{\delta\theta}{2}$ $Rn = T\delta\theta$	1

	- Equating Equation i & ii $T\delta\theta = \delta\frac{T}{\mu}$ $\frac{\delta T}{T} = \mu\delta\theta$ - Integrating above equation and applying limits T_2 and T_1 and θ from 0 to θ respectively. $\int_{T_2}^{T_1}\frac{\delta T}{T} = \int_{\theta}^{\theta}\mu\delta\theta$ $[\log T]_{T_2}^{T_1} = \mu[\theta]_0^{\theta}$ $\log_e(T_1/T_2) = \mu\theta$ $\frac{T_1}{T_2} = e^{\mu\theta}$	1 1
b.	**<u>Effect of slip on Velocity Ratio</u>**. <u>Slip</u>:- As the belt is not a positive drive there is a difference in linear speed of the rim of pulley and the belt on the pulley. This difference in speed is called as slip in belt drive. - The slip is generally expressed as percentage. The slip results into reduction of velocity of the system. - The slip can occur on both the driver and driven pulley i.e. the driver pulley may move forward without carrying belt with it and the belt may move forward without carrying the drive pulley with it. Let S = Total percentage slip. Then, the Velocity Ratio, $\frac{N_2}{N_1} = \frac{d_1}{d_2}\frac{(100-S)}{100}$ d_1 = dia. of driver pulley. d_2 = dia. of driven pulley. N_1 = speed of driver pulley in r.p.m. N_2 = speed of driven pulley in r.p.m. If S_1 = percentage slip on driver S_2 = percentage slip on driven. Then velocity ratio $\frac{N_2}{N_1} = \frac{d_1}{d_2}\times\frac{(100-S_1)}{100}\times\frac{(100-S_2)}{100}$	2

	Effect of creep on velocity ratio. - The length of belt approaching the driver pulley is more than length of belt leaving the driver pulley. It causes a relative motion of the belt on the pulley. This relative motion is called creep in bets. - Considering the creep the velocity ratio is given by $\frac{N_2}{N_1} = \frac{d_1}{d_2} \times \left[\frac{E+\sqrt{f2}}{E+\sqrt{f1}}\right]$ Where E = young's modulus for the material of belt. F_1 = stress in the belt material on tight side. F_2 = stress in the belt material on slack side. - The effect of creep is to reduce the speed of driven pulley than the peripheral velocity of the pulley.	**2**
c.	Working principle of epicyclic gear train  - The epicyclic gear trains may consist of a simple, compound or mixed gear trains. - A simple type of epricyclic gear train is shown in fig. Which has the driving gear A, the driven gear B and the arm C. The gear A & the arm C have the common axis R about which they can rotate. - The gear A drives the gear B about an axis S. If we assume arm C to be fixed the same gear train behave like simple gear train. - However, in case the arm C rotates and the gear A is fixed, then the train becomes epicyclic gear train.	**2** **2**
d.	Given data, Power = P = 40 kw = 40 x 10^3 w T max = 40 N/mm = 400 N/cm of width = 400 b Velocity = V = 50 m/sec. Angle of lap $\theta = 170^0 \times \frac{\pi}{180} = 2.96\ rad.$ Coefficient of friction = μ = 0.24	**1**

	$\frac{T_1}{T_2} = e^{\mu\theta}$ $= e^{(0.24\times2.96)}$ $\frac{T_1}{T_2} = 2.034$ $P = \frac{(T_1 - T_2)V}{1000}$ $40\times10^3 = \frac{\left(T_1 - \frac{T_1}{2.034}\right)\times50}{1000}$ $T_1 = 1016.71N$	1

	max. Tension, T max $= 400b = T_1$ $\therefore 400b = T_1$ $\therefore b = \frac{T_1}{400}$ $\therefore b = \frac{1016.71}{400}$ $\therefore b = 2.54\,cm$ $b = 25.4\,mm$	1 1
e.	<u>Methods of lubrication of chain drive</u> 1. Manual or drip lubrication 2. Oil stream lubrication 3. Bath or disk lubrication <u>Explanation of any one method</u> 1. <u>Manual lubrication</u> - when lubrication is used oil is applied periodically with a brush or spout can, preferable once every 8 hours operation. Volume & frequency should be sufficient to prevent discolorization of the lubricant in the chain joints. <u>Drip lubrication</u> – when drip lubrication is used oil drops are directed between the link plate edges by a drip lubricated volume & frequency should be sufficient to prevent discolorization of the lubricant in the chain joint. 2. <u>Oil stream lubrication</u> – The lubrication is usually supplied in a continuous stream to each chain drive. Oil should be applied inside the chain loop, evenly across the chain width and directed preferably at the slack strand. 3. <u>Bath or disk lubrication</u> – In bath lubrication the lower part of the chain run through the oil sump in the drive housing. The dynamic oil level should be at the pitch line of the chain is lowest operating point. Disk lubrication, the chain operates above oil level. The disk pickup the oil from the sump and deposit on the chain by a trough.	1 3
f.	<u>Types of follower</u> i) <u>According to shape</u>	2

	1. Knife edge follower 2. Flat face or mushroom follower 3. Roller follower 4. Spherical follower ii) <u>According to types of motion of follower</u> 1. Reciprocating follower 2. Oscillating follower iii) <u>According to line of motion of follower</u> 1. Radial follower 2. Offset follower	1 1

Q.4. a.	<u>Given data</u> Length of crank = r = 250 m = 0.25m Length of connection rod = l = 1000 mm = 1m Speed of crank N = 150 rpm Obliquity const. $= l/r = \frac{1000}{250} = 4$ Crank angle with IDC = 30^0 Ang. speed of crank $= \frac{2\pi N}{60}$ $\omega = \frac{2\pi \times 150}{60}$ $\omega = 5\pi \quad rad/S$	
	a) <u>Velocity of piston</u> $Vp = Vs = w.r.\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$ $= 5\pi \times 0.25\left[\sin 30 + \frac{\sin 60}{2\times 4}\right]$ $= 2.388$ $Vp = 2.4\ m/\sec$	**2**
	b) <u>Acceleration of piston</u> $ap = w^2.r.\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$ $= (5\pi)^2(0.25)\left[\cos 30 + \frac{\cos 60}{4}\right]$ $= (5\pi)^2 \times 0.2477$ $ap = 61.11\ m/S^2$	**2**
	c) <u>Angular velocity of connecting rod (ω_{AB})</u> $\omega_{AB} = \frac{\omega_{OB} \times \cos\theta}{n}$ $= \frac{(5\pi)\times \cos 30}{4}$ $\omega_{AB} = 3.4\ rad/\sec$	**2**
	d) <u>Angular acceleration of connecting rod</u> $\alpha_{AB} = -\frac{\omega^2 \times \sin\theta}{n}$ $= -\frac{(5\pi)^2 \times \sin 30}{4}$ $\alpha_{AB} = -30.84\ rad/S^2$	**2**

b.	<u>Given data</u> Outstroke of follower = 40 mm Angle of action for outstroke = $\frac{1}{4} \times revolutoon$	

$= \frac{1}{4} \times 360$

$= 90^0$

Angle of action for dwell $= \frac{1}{10} \times revolution$

$= \frac{1}{10} \times 360$

$= 36^0$

Angle of action for return stroke $= \frac{1}{6} \times revolution$

$= \frac{1}{6} \times 360$

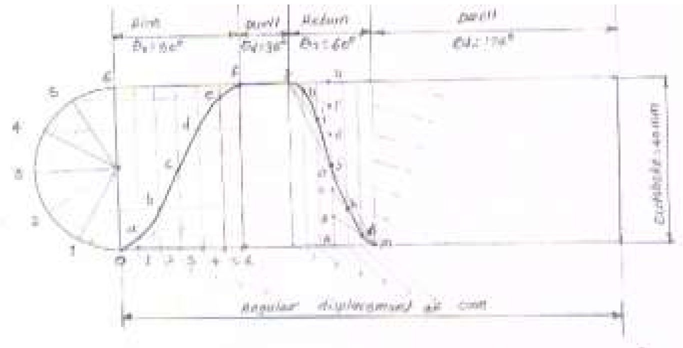
2

$= 60^0$

Diameter of roller = 20 mm

radius of roller = 10 mm

minimum radius of cam = 30 mm



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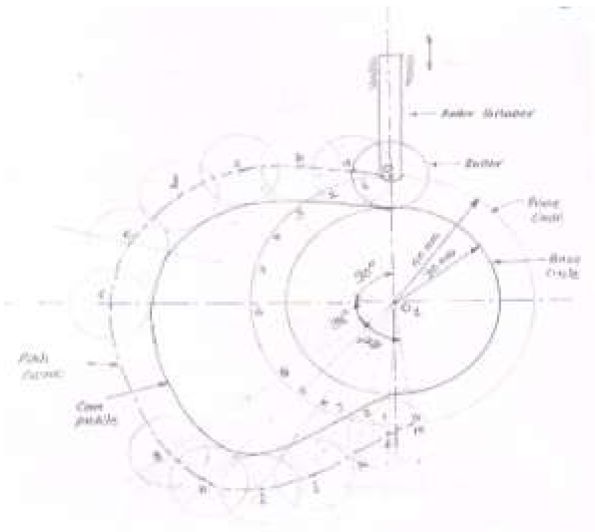

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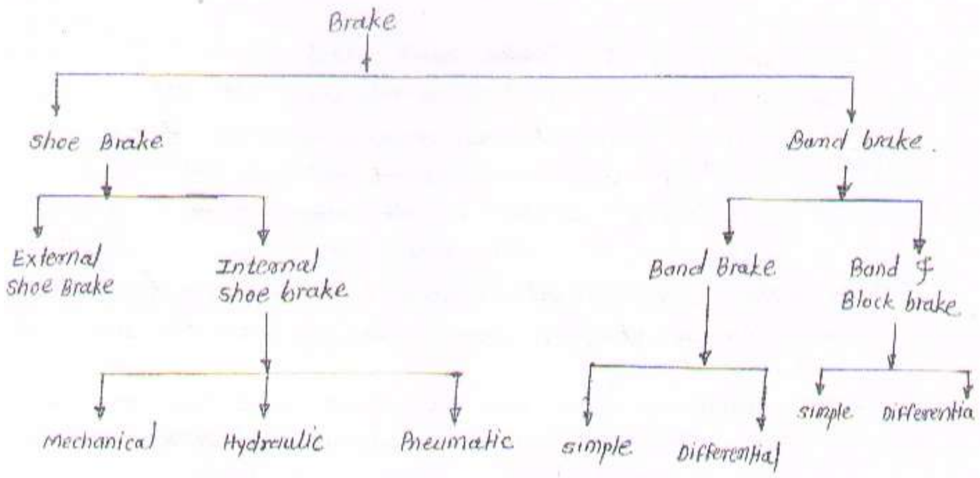
c.	Different types of brakes.	

Different types of brakes.



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Internal expanding shoe brake:-

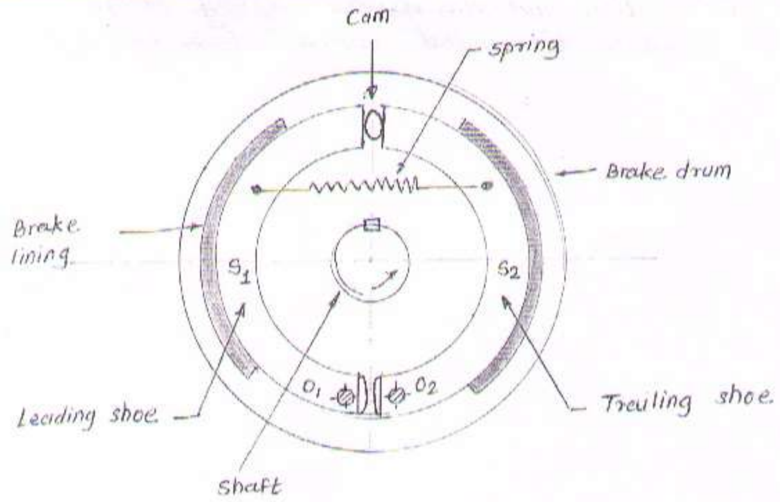

Fig:- Internal expanding shoe brake (Mechanical type)

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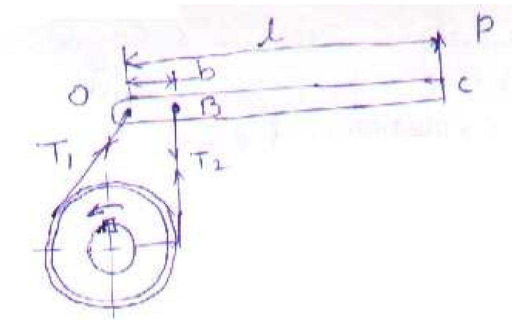
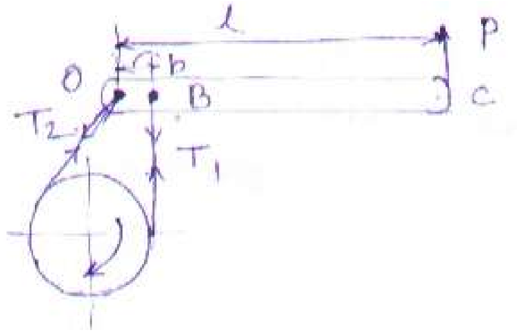
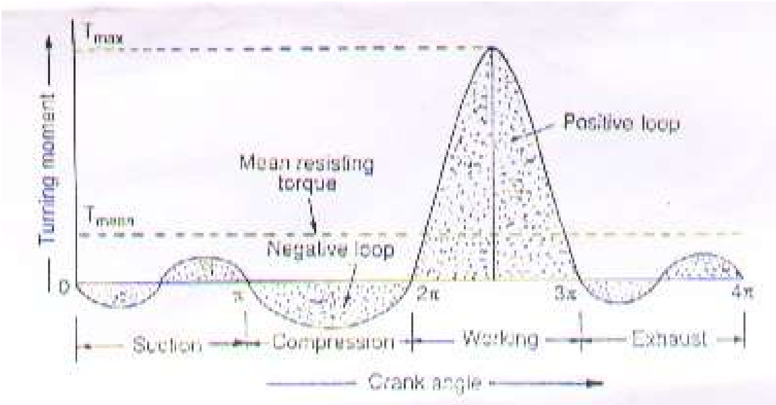
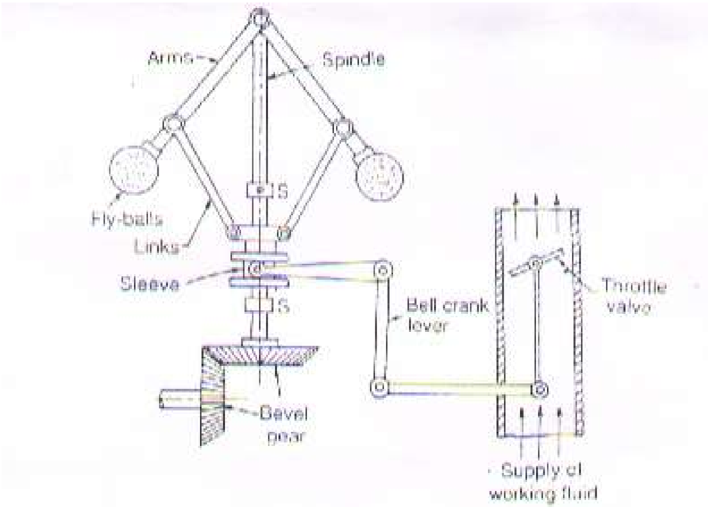
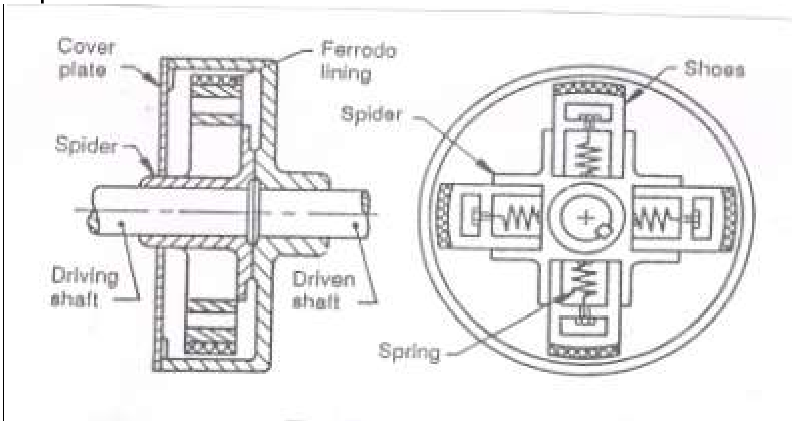
	- Fig. Shows the mechanically operated internal expanding shoe brake. - It consists of two brake shoes which are mounted inside the brake drum. The shoes are pivoted at their heels. - A cam is mounted between the two brake shoes. It is connected to the brake pedal through mechanical linkages. - A brake liners mounted on the brake shoes. A retrieving spring is mounted between the brake drum. - As the brake pedal is pressed, the mechanical linkage rotates the cam so that it applies the force on the toe of the brake shoes.	4

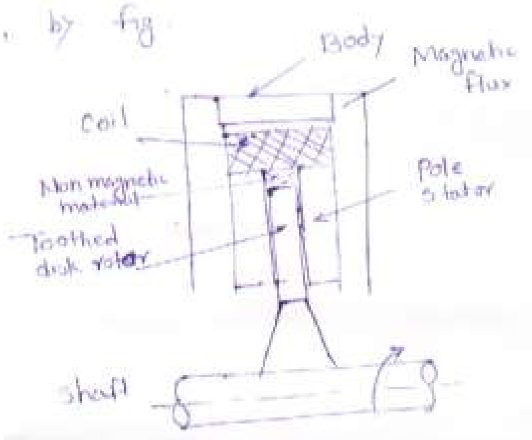
	- The brake shoes go away from each other and the liners are pressed against the brake drum and the brake shoes go away from each other & the brake is applied. - As the brake pedal is released, the cam rotates back to initial position and the retrieving spring brings the brake shoe back to the initial position and braking force is released.	
Q.5. a.	<u>Given data – Band Brake</u> d = 500 mm r = 250 mm = 0.25 m T = 225 N-m b = OB = 120 mm = 0.12 m l = 550 mm = 0.55 m μ = 0.3 P = operating force (effort) i) Operating force when drum rotates in anticlockwise direction. One end of the band is attached to the fulcrum at O therefore the oprating force P will act upward. (anticlockwise) T_1 = Tension in the tight side of band T_2 = Tension in the slack side of band <u>Angle of wrap</u> $\theta = \frac{3}{4}$ of circumference $= \frac{3}{4} \times 360 = 270^0$ $= 270 \times \frac{\pi}{180} = 4.713\ rad$ $\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3 \times 4.713}$ $\frac{T_1}{T_2} = 4.12$ $T_1 = 4.12\ T_2 \qquad equn\ i$  <u>Brake torque T</u> $T = (T_1 - T_2) r = (T_1 - T_2) 0.25 = 225$ $T_1 - T_2 = 900\ N \qquad equn\ ii$ <u>from equation i & ii</u> $4.12\ T_2 - T_2 = 900 \quad \therefore T_2 = 289\ N$ $T_1 = 1189\ N$ Taking moment about the fulcrum O $P \times l = T_2 \times b$ $P \times 0.55 = 289 \times 0.12$ $P = 63.05\ N$	 **1** **1** **1**

	ii) Operating force when drum rotates in clockwise direction. When the drum rotates in clockwise direction, then taking moment about the fulcrum O $P \times l = T_1 \times b$ $P \times 0.55 = 1189 \times 0.12$ P = 260 N 	1
b.	Turning moment diagram for a four stroke I.C. engine- In a four stroke cycle I.C. engine, there is one working stroke after the crank has turned through two revolutions. i.e. 720^0 or 4π Radians.  ----------Crank angle--------- Turing moment diagram for a four stroke cycle internal combustion engine.	2
	Since the pressure inside the engine cylinder is less than the atmospheric pressure during the suction stroke, therefore a negative loop is formed as shown in fig. During the compression stroke, the work is done on the gases, therefore a higher negative loop is obtained. During the expansion or working stroke, the fuel burns and the gases expand; therefore a large positive loop is obtained. In this stroke, the gases do the work. During exhaust stroke, the work is done on the gases, therefore a negative loop is formed. It may be noted that the effect of the inertia forces on the piston is taken into account in fig.	2
c.	**Working principle of centrifugal governor** The centrifugal governors are based on the balancing of centrifugal force on the rotating balls by an equal and opposite radial force. The balls revolve with a spindle, which is driven by the engine through bevel gears. The upper ends of the arms are pivoted to the spindle, so that the balls may rise up or fall down as they revolve about the vertical axis. The arms are connected by the links to a sleeve, which is keyed to the spindle. This sleeve revolves with the spindle; but can slide up and down. The balls and the sleeve rises when the spindle speed increases, and falls when the speed decreases. In order to limit the travel of the sleeve in upward and downward directions, two stops S,S are provided on the spindle. The sleeve is connected by a bell crank lever to a throttle valve. The supply of the working fluid decreases when the sleeve rises and increases when it falls.	1

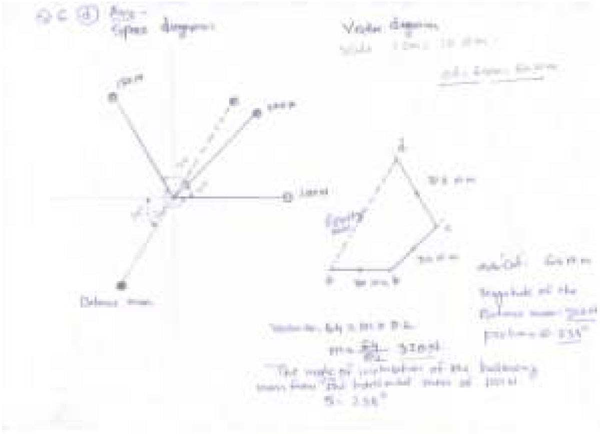
Q.5. c.	 Centrifugal governor When the load on the engine increases. The engine and the governor speed decreases. This results in the decrease of centrifugal force on the balls. Hence the balls move inwards and the sleeve moves downwards. The downward movement of the sleeve operates a throttle valve at the other end of the bell crank lever to increase the supply of working fluid and thus the engine speed is increased. In this case, the extra power output is provided to balance the increased load. When the load on the engine decreases, the engine and the governor speed increases, which results in the increase of centrifugal force on the balls. Thus the balls move outwards and the sleeve rises upwards. This upward movement of the sleeve reduces the supply of the working fluid and hence the speed is decreased. In this case, the power output is reduced.	**2** **1**
d.	<u>Stability of Governors</u> A governor is said to be stable when for every speed within the working range there is a definite configuration. For a stable governor, if the equilibrium speed increase, the radius of governor balls must also increase. <u>Hunting of Governor</u> A governor is said to be hunt if the speed of the engine fluctuates continuously above and below the mean speed. This is caused by a too sensitive governor, which changes the fuel supply by a large amount when a small change in the speed of rotation take place. As the speed falls to below the mean value, the sleeve again moves rapidly and falls to a minimum position to increase the fuel supply. The speed subsequently rises and becomes more than the average with the result that the sleeve again rises to reduce the fuel supply. This process continues and is known as hunting.	**2** **2**

e.	Given conical pivot bearing $W = 20\ kN = 20\times10^3\ N$ $2\alpha = 120^0 \qquad \alpha = 60^0$ $Pn = 0.35MN/m^2 = 0.35\times10^6\ N/m^2\ \mu = 0.05$ $N = 120\ rpm$ $\omega = \frac{2\pi N}{60} = \frac{2\pi\times120}{60} = 12.57\ rad/\sec$ r_1 = outer radii of the bearing surface r_2 = inner radii of the bearing surface $r_1 = 3r_2$ i) intensity of normal pressure $Pn = \frac{W}{\pi[(r_1)^2 - (r_2)^2]} = \frac{20\times10^3}{\pi[(3r_2)^2 - (r_2)^2]}$ $0.35\times10^6 = \frac{20\times10^3}{\pi(8r_2^2)}$ $r_2^2 = \frac{20\times10^3}{0.35\times10^6\times\pi\times8} = 2.27\times10^{-3}$ $r_2 = 0.048m = 48mm$ $\therefore r_1 = 3r_2 = 3\times48 = 144mm$	 1 1
	ii) power absorbed in friction $T = \frac{2}{3}\mu w \cos ec\alpha\left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right] \quad (uw\ form\ pressure)$ $T = \frac{2}{3}\times0.05\times20\times10^3\times\cos ec\ 60\left[\frac{144^3 - 48^3}{144^2 - 48^2}\right]$ $T = 120093\ N-mm = 120.093\ N-m$ power absorbed in friction P = T w = 120.093 x 12.57 = 1510 watt = 1.510 kw	 1 1
f.	Centrifugal Clutch 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 shoe is revolving. A little consideration will show that when the centrifugal force is less than the spring force, the shoe remain 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 cones 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	2

	spring force. The increase of speed causes the shoe to press harder and enables more torque to be transmitted  Fig. 10.23. Centrifugal clutch.	2

Q.6. a.	When the frictional force is great enough to apply the brake with no external force, then the brake is said to be self-locking brake. - Single block or shoe brake used in Railways. Material of brake – (for facing or lining of brake) - Cast iron on cast iron - Bronze on cast iron - Steel on cast iron - Wood on cast iron - Cork on metal - Leather on metal - Asbestos on metal	**2** **1** **1**
b.	<u>Principle of operating of an eddy current dynamometer</u> Based on eddy current (Fleming law of right hand) A hatched disc (rotor) which is driven by a prime mover such as engine and magnetic poles (stators) are located outside of it with a gap. The coil which excites the magnetic pole is wound in circumference direction. When a current rung through exciting coil, a magnetic flux loop is formed around the exciting coil through stators and a rotor. The rotation of rotor produces density difference then eddy current goes to stator. The electromagnetic force applies in opposite of the rotational direction by the product of this eddy current and vector of magnetic flux and its becomes brake.  	**2** **2**
c.	<u>Given</u> Multiple plate clutch No. of effective surface n = 9 Power = 60 kw = 60 x 10^3 watt	

	N = speed = 1200 rpm P max. = 1×10^5 N/m^2 $r_2 = 0.8\ r_1$ $\mu = 0.25$ Find r_1 & r_2 $R = \frac{r_1 + r_2}{2} = \frac{1.25\ r_2}{2} = 1.125\ r_2$ Power transmitted $P = \frac{2\pi\ NT}{60}$ $T = \frac{60 \times 60 \times 1000}{2\pi \times 1200} = 478\ N-m$ Torque transmitted $T\ =\ n\mu wR$ $478\ =\ 9 \times 0.25 \times w \times R \quad \therefore\ w\ =\ \frac{478}{9 \times 0.25 \times 1.25\,r_2}$ $w\ =\ 189 / r_2 \quad equn\ i$ Intensity of pressure is maximum at the inner radius P max r_2 = C $1 \times 10^5 \times r_2$ = C The axial force required to engage the clutch W = 2π C($r_1 - r_2$) W = $2\pi \times 1 \times 10^5 r_2 (1.25 r_2 - r_2) = 1.57 \times 10^5 r^2_2$ equn ii Equn i & ii $\frac{189}{r_2} = 1.57 \times 10^5 r_2^2$ $r_2^3 = 1.203 \times 10^{-3}$ $r_2 = 0.1060 m = 106.4 mm$ $\therefore\ r_2\ = 106\ mm$ $\therefore\ r_1\ = \frac{106}{0.8} = 133\ mm\ =\ 0.133\ m$ $\therefore\ r_1\ = 133\ mm \quad \& \quad r_2\ = 106\ mm$	1 1 1 1
d.	<u>Given</u> m_1 = 100 N r_1 = 0.3 m $\theta_1 = 45^0$ (m_1 & m_2) m_2 = 200 N r_2 = 0.15 m $\theta_2 = 75^0$ (m_2 & m_3) m_3 = 150 N r_3 = 0.25 m $\theta_1 = 240^0$ (m_3 & m_4) <u>Centrifugal force of each mass</u> $m_1 r_1$ = 100 x 0.3 = 30 N-m $m_2 r_2$ = 200 x 0.15 = 30 N-m $m_3 r_3$ = 150 x 0.25 = 37.5 N-m	1

	<u>Vector diagram</u>  1 mark 1 mark - The closing side of the polygon 'ad' represent the resultant force. By measurement. ad = 64N – m - The balancing force is equal to the resultant force but opposite in directions. m x 0.2 = Vector ad = N – m m = 64 / 0.2 = 320 N ∴Angle of inclination of the balancing mass (m) 1. θ = 235^0	**1**
e.	i) <u>Amplitude of vibration</u> - When the system is under damped. The amplitude of the vibration decrease with time, the ratio of successive amplitudes being const. - The maximum displacement of a vibrating particle or body from its position of rest. ii) <u>Frequency of vibration</u> - An undamped system, vibrates at its frequency which depends upon the static deflection under the weight of its mass. - When the system is under damped, the frequency of the system decrease and time period increases. - A critical damping occure when frequency of damped vibration is zero. ------The End ------	2 2