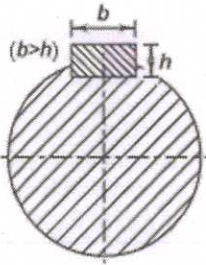


Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
PART-A (Answer all questions)				
1	<p>The efficiency of a screw jack may be defined as the ratio between the ideal effort (i.e. the effort required to move the load neglecting friction) to the actual effort (i.e. the effort required to move the load taking friction into account)</p> <p style="text-align: center;">Or</p> $\text{Efficiency} = \frac{\text{Ideal effort}}{\text{Actual effort}}$	2	2	10
2	<p>1.Sleeve or muff coupling 2.Flange coupling</p>	1 1	2	
3	The base circle is the smallest circle tangent to the cam profile drawn from the centre of rotation of a cam	2	2	
4	Turning moment diagram is the graphical representation of the turning moment or torque for various positions of the crank		2	
5	<p>Circular pitch is the distance between the corresponding point of successive teeth measured along the circumference of the pitch circle.</p> <p style="text-align: center;">Or</p> $P_c = \frac{\pi d}{T}$	2	2	
PART-B (Answer any 5 questions)				
1	<p>Torque required to lower the load</p> $T = W \tan(\phi - \alpha) \times \frac{d_m}{2}$ <p>If $\alpha > \phi$, the torque required to lower the load will be negative, which means that the load will lower itself without the application of any effort or torque. Such a condition is known as overhauling of screws.</p> <p>If $\alpha < \phi$, the torque required to lower the load will be positive, which means that an effort or torque is required to lower the load. Such a condition is known as self-locking</p>	2 2 2	6	30

2.

1. Sunk key

A sunk key is a key in which half the thickness of the key fits into the keyway on the shaft and the remaining half in the keyway on the hub.

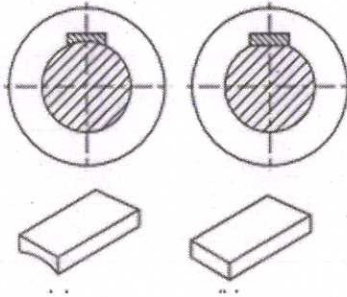


2

6

2. Saddle key

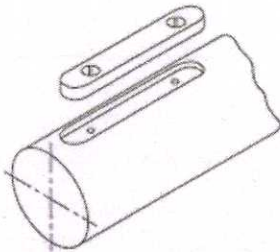
A saddle key is a key which fits in the keyway of the hub only.



2

3. Feather key


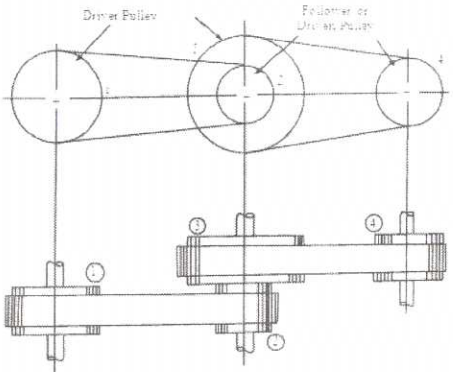
A feather key is a parallel key which is fixed either to the shaft or to the hub and which permits relative axial movement between them.



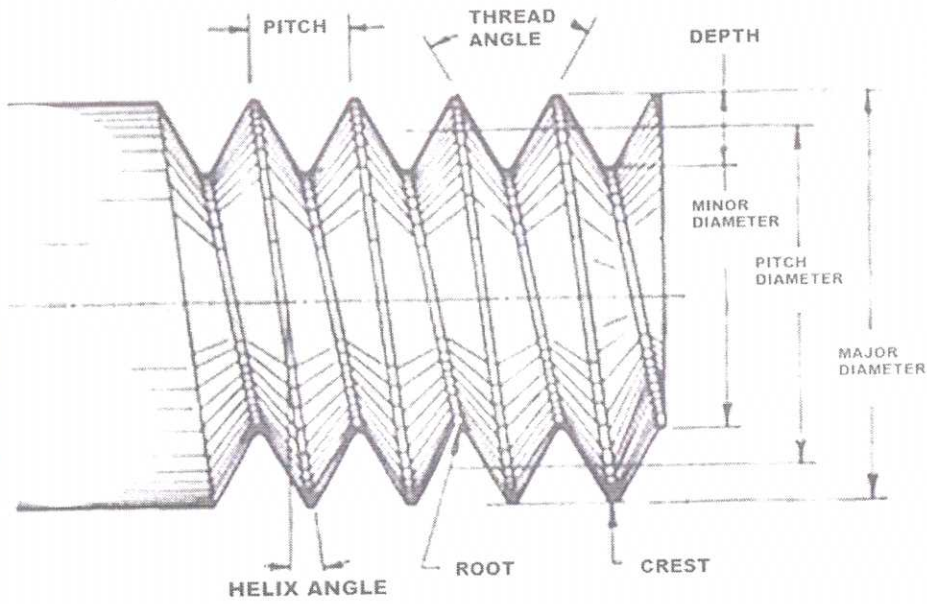
Feather key

2

<p>3</p>	<p><u>SHAFT DESIGN ON STRENGTH BASIS</u></p> <p>In this method the shaft diameter is calculated in such a way that the induced shear stress should be less than the permissible shear stress of the shaft material.</p> $T = \frac{\pi}{16} \tau d^3$ $d = \sqrt[3]{\frac{16T}{\pi\tau}}$ <p>Where, d= shaft diameter in mm. T = Toque to be transmitted in Nmm τ =Permissible shear stress of the shaft material.</p> <p><u>SHAFT DESIGN ON RIGIDITY BASIS</u></p> <p>A transmission shaft is said to be rigid on the basis of torsional rigidity, if it does not twist too much under the action of an external torque. In this method the shaft diameter is calculated in such a way that the angle of twist should be less than the permissible angle of twist of the shaft material.</p> $\theta = \frac{584Tl}{Gd^4}$ $d = \sqrt[4]{\frac{584Tl}{G\theta}}$ <p>Where, d= shaft diameter in mm. T = Toque to be transmitted in Nmm l = Length of the shaft in mm G = Modulus of rigidity of the shaft material in N/mm² θ = Permissible angle of twist in degrees.</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>6</p>	
<p>4</p>	<p>A governor is said to be sensitive when it readily responds to a small change of speed. The bigger the displacement of sleeve for a fractional change of speed, the more sensitive is the governor.</p> <p>Sensitiveness of the governor = $\frac{\text{Mean equilibrium speed}}{\text{Range of speed}}$</p> <p>If a governor is too sensitive, it may fluctuate continuously above and below the mean speed when the load on the engine falls or increase. This process is known as hunting.</p>	<p>2</p> <p>2</p> <p>2</p>	<p>6</p>	

<p>5</p>	<p><u>THRUST BEARING</u> In thrust bearing, the main load acts along the axis of rotation of the shaft.</p> <p>If the shaft is vertical and the end of the shaft rests on the bearing surface, it is known as pivot or foot-step bearing.</p> <p>A collar bearing is one in which shaft continues through the bearing and a collar takes the end pressure of the shafts. A shaft may be with single collar or many collar.</p>  <p>(a) Flat pivot. (d) Single flat collar. (e) Multiple flat collar.</p>	<p>1</p> <p>1</p> <p>1</p> <p>3</p>	<p>6</p>	
<p>6</p>	<p><u>GEAR DRIVE</u></p> <ol style="list-style-type: none"> 1.They give positive drive and constant speed ratio without any slippage. 2. The drive is more compact due to short centre distance between shafts. 3. It can be operated at higher speeds. 4. Not suitable for large centre distances 5.Requires perfect alignment of shafts. <p><u>BELT DRIVE</u></p> <ol style="list-style-type: none"> 1.Suitable for comparatively long centre distances. 2.Low velocity ratio. 3. It is not a positive drive. Possibility of slip is there. 4.Belt drives occupies more space compared to gear drive. 	<p>3 (Any 3 points)</p> <p>3 (Any 3 points)</p>	<p>6</p>	
<p>7</p>	<p>If the power is transmitted from one shaft to another through a number of pulleys is known as compound belt drive. In this case pulley 1 drive pulley 2 and pulley 3. Pulley 2 and pulley 3 are keyed on the same shaft. Pulley 3 drives the pulley 4. Therefore pulley 1 and 3 are the drivers and pulley 2 and 4 are driven or followers.</p> 	<p>3</p> <p>3</p>	<p>6</p>	

III.a



1. Major diameter
2. Minor diameter
3. Pitch diameter
4. Root
5. Crest
6. Helix angle
7. Pitch
8. Thread angle
9. Depth of thread

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
III b	<p>Power transmitted, $P = \frac{2\pi NT}{60}$</p> <p>Torque transmitted, $T = \frac{60P}{2\pi N}$</p> $= \frac{60 \times 20 \times 10^3}{2\pi \times 200} = 954.93 \text{ Nm} \quad (1)$ $= \underline{\underline{954.93 \times 10^3 \text{ Nmm}}} \quad (1)$ <p>considering shear strength of key,</p> $T = l w z \times \frac{d}{2} \quad (1)$ <p>Induced shear stress, $\tau = \frac{2T}{l w d}$</p> $= \frac{2 \times 954.93 \times 10^3}{80 \times 14 \times 50}$ $= \underline{\underline{34.104 \text{ N/mm}^2}} \quad (1)$ <p>Considering crushing strength of key,</p> $T = l \times \frac{t}{2} \times \sigma_c \times \frac{d}{2}$ <p>Induced crushing stress, $\sigma_c = \frac{4T}{l t d} \quad (1)$</p> $= \frac{4 \times 954.93 \times 10^3}{80 \times 14 \times 50} = \underline{\underline{68.21 \text{ N/mm}^2}} \quad (1)$	(1)	7	

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
<u>IV</u> a.	<p>Helix angle, $\alpha = \tan^{-1} \left(\frac{n p}{\pi d_m} \right)$</p> $= \tan^{-1} \left(\frac{1 \times 12}{\pi \times 60} \right) = \underline{3.64^\circ}$ <p>Friction angle, $\phi = \tan^{-1} \mu = \tan^{-1} 0.1 = \underline{5.71^\circ}$</p> <p>Effort required at the mean circumference of the threads to lift the load, $P = W \tan (\alpha + \phi)$</p> $= 30 \times 10^3 \times \tan (3.64 + 5.71)$ $= \underline{4939.57 \text{ N}}$ <p>Using the relation, $T = P' \times L = P \times \frac{d_m}{2}$</p> <p>Effort applied at the end of the lever to lift the load, $P' = \frac{P \times d_m}{2L}$</p> $= \frac{4939.57 \times 60}{2 \times 500} = \underline{296.37 \text{ N}}$	(1) (1) (2) (1) (1) (1) (1)	8	
<u>IV</u> b	<p>The force acting on the cylinder head of engine, $P = \frac{\pi}{4} D^2 \times p$ — (a) (1)</p> <p>Resistance offered by the bolts,</p> $P = \frac{\pi}{4} d_c^2 \sigma_t n$ — (b) (1)	(1) (1)		

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
	<p>equating equations (a) & (b)</p> $\frac{\pi}{4} D^2 \times p = \frac{\pi}{4} d_c^2 \sigma_t n$ $d_c = \sqrt{\frac{D^2 \times p}{\sigma_t \times n}} = \sqrt{\frac{460^2 \times 0.85}{20 \times 12}}$ $= \underline{\underline{23.80 \text{ mm}}}$ <p>Nominal diameter, $d = \frac{d_c}{0.84} = 28.33 \text{ mm}$</p> $\approx \underline{\underline{30 \text{ mm}}}$	<p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(2)</p>	<p>7</p>	
Va	<p><u>Design of shaft</u></p> <p>Diameter of shaft, $d = 100 \text{ mm}$</p> <p><u>Design of hub</u></p> <p>Inside diameter of hub, $d = 100 \text{ mm}$.</p> <p>Outside diameter of hub, $D = 2d$</p> $= 200 \text{ mm}$ <p>Length of hub, $L = 1.5d = 150 \text{ mm}$</p> <p>Torque transmitted by the hub,</p> $T_{\max} = \frac{\pi}{16} \tau_h D^3 (1 - k^4)$ <p>Induced shear stress in cast iron hub,</p> $\tau_h = \frac{16 T_{\max}}{\pi (1 - k^4) D^3} = \frac{16 \times 6 \times 10^6}{\pi \left(1 - \left(\frac{100}{200}\right)^4\right) 200^3}$ $= \underline{\underline{4.07 \text{ N/mm}^2}}$	<p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p>		

Q.
No.

SCORING INDICATOR

SPLIT
UP
SCORESUB
TOTAL

TOTAL

Induced shear stress < Allowable shear stress
Hence the design is safe.

Design of Flange

Outside diameter of flange, $D_o = 4d$

$$= \underline{400 \text{ mm}} \quad \left(\frac{1}{2}\right)$$

Thickness of flange, $t_f = 0.5d = \underline{50 \text{ mm}}$ $\left(\frac{1}{2}\right)$

$$T_{\max} = \pi D t_f \tau_f \times \frac{D}{2} \quad \left(\frac{1}{2}\right)$$

Induced shear stress in the cast iron

$$\text{flange, } \tau_f = \frac{2T_{\max}}{\pi D^2 t_f} = \frac{2 \times 6 \times 10^6}{\pi \times 200^2 \times 50}$$

$$= \underline{1.91 \text{ N/mm}^2} \quad \left(\frac{1}{2}\right)$$

Induced shear stress < Allowable shear stress.

Hence the design is safe.

Design of Key

$\sigma_{ck} = 2\tau_k$, Adopt square key.

$$\text{Width, } w = \frac{d}{4} = \frac{100}{4} = \underline{25 \text{ mm}} \quad \left(\frac{1}{2}\right)$$

Thickness of the key, $t = w = \underline{25 \text{ mm}}$.

Length of key in each shaft, $l = L = 150 \text{ mm}$. $\left(\frac{1}{2}\right)$

$$\text{Torque Transmitted, } T_{\max} = lw\tau_k \times \frac{d}{2} \quad \left(\frac{1}{2}\right)$$

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
	$T_{max} = l \frac{t}{2} \sigma_{ck} \times \frac{d}{2}$ <p>Induced shear stress in the key,</p> $\tau_k = \frac{2T_{max}}{lWd} = \frac{2 \times 6 \times 10^6}{150 \times 25 \times 100}$ $= \underline{\underline{32 \text{ N/mm}^2}}$ <p>Induced crushing stress in the key,</p> $\sigma_{ck} = \frac{4T_{max}}{ltd} = \frac{4 \times 6 \times 10^6}{150 \times 25 \times 100}$ $= \underline{\underline{64 \text{ N/mm}^2}}$ <p>The induced shear stress & crushing stress are less than the allowable values.</p> <p><u>Design of Bolts</u></p> <p>Number of bolts, $n = \frac{4d}{150} + 3$</p> $= \left(\frac{4 \times 100}{150} \right) + 3 = 5.67 \approx \underline{\underline{6}}$ <p>Pitch circle diameter, $D_p = 3d = \underline{\underline{300 \text{ mm}}}$</p> <p>considering shearing strength of bolts,</p> $T_{max} = \frac{\pi}{4} d_i^2 n \tau_b \times \frac{D_p}{2}$ <p>Nominal diameter of bolts, $d_i = \sqrt{\frac{8T_{max}}{\pi n \tau_b D_p}}$</p> $= \sqrt{\frac{8 \times 6 \times 10^6}{\pi \times 6 \times 50 \times 300}} = 13.03 \approx \underline{\underline{14 \text{ mm}}}$	<p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p>	<p>9</p>	

Q.
No.

SCORING INDICATOR

SPLIT
UP
SCORESUB
TOTAL

TOTAL

M14 bolt can be used.

checking for crushing strength,

$$\sigma_{cb} = \frac{2T_{max}}{d_1 t_f n D_p} = \frac{2 \times 6 \times 10^6}{14 \times 50 \times 6 \times 300}$$

$$= \underline{\underline{9.52 \text{ N/mm}^2}}$$

Induced crushing stress is less than
Permissible crushing stress.

Hence the design is safe.

V
b

$$P = \frac{2\pi NT}{60}$$

$$\text{Torque transmitted, } T = \frac{60 P}{2\pi N}$$

$$= \frac{60 \times 1.5 \times 10^6}{2\pi \times 200} = 71619.72 \text{ Nm}$$

$$= \underline{\underline{71619.72 \times 10^3 \text{ Nmm}}} \quad (1)$$

Design based on rigidity

$$\theta = \frac{584 T l}{G d^4} \quad (1)$$

6

$$\text{Diameter of shaft, } d = \sqrt[4]{\frac{584 T l}{G \theta}}$$

$$= \sqrt[4]{\frac{584 \times 71619.72 \times 10^3 \times 1 \times 10^3}{84 \times 10^3 \times 1}}$$

$$= 149.38 \text{ mm} \approx \underline{\underline{150 \text{ mm}}} \quad (2)$$

Q. No.

SCORING INDICATOR

SPLIT
UP
SCORESUB
TOTAL

TOTAL

$$T = \frac{\pi}{16} \tau d^3$$

shear stress induced, $\tau = \frac{16T}{\pi d^3}$ (1)

$$= \frac{16 \times 71619.72 \times 10^3}{\pi \times 150^3}$$

$$= \underline{\underline{108.07 \text{ N/mm}^2}}$$
 (1)

VI
a.

Design of shaft

$$T_{\text{mean}} = \frac{60P}{2\pi N} = \frac{60 \times 100 \times 10^3}{2\pi \times 200}$$

$$= 4774.65 \text{ Nm}$$

$$= \underline{\underline{4774.65 \times 10^3 \text{ Nmm}}} \quad (1)$$

$$T_{\text{max}} = T_{\text{mean}}$$

$$\text{Diameter of shaft, } d = \sqrt[3]{\frac{16 T_{\text{max}}}{\pi \tau_s}}$$

$$= \sqrt[3]{\frac{16 \times 4774.65 \times 10^3}{\pi \times 55}} = \underline{\underline{76.18 \text{ mm}}}$$

Adopt diameter of shaft as

$$d = \underline{\underline{80 \text{ mm}}} \quad (1)$$

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
	<p><u>Design of sleeve</u></p> <p>Inside diameter of sleeve, $d = 80\text{mm}$</p> <p>outside diameter of sleeve, $D = 2d + 13$</p> $= (2 \times 80) + 13 = \underline{173\text{mm}}$ <p>Length of sleeve, $L = 3.5d = 3.5 \times 80$</p> $= \underline{280\text{mm}}$ $T_{\text{max}} = \frac{\pi}{16} \tau_m D^3 (1 - k^4)$ <p>Induced shear stress in the sleeve,</p> $\tau_m = \frac{16 T_{\text{max}}}{\pi D^3 (1 - k^4)} = \frac{16 \times 4774.65 \times 10^3}{\pi (173^3) \left(1 - \left(\frac{80}{173}\right)^4\right)}$ $= \underline{4.92\text{N/mm}^2}$ <p>The induced shear stress is less than permissible shear stress. Hence the design is safe.</p> <p><u>Design of key</u></p> <p>$\sigma_{ck} = 2\tau_k$, Adopt square sunk key</p> <p>width of key, $w = \frac{d}{4} = \frac{80}{4} = 20\text{mm}$</p> <p>Thickness of the key, $t = w = 20\text{mm}$</p> <p>Length of key in each shaft, $l = \frac{L}{2} = \frac{280}{2}$</p> $= \underline{140\text{mm}}$	<p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1)</p> <p>(1/2)</p> <p>(1/2)</p> <p>(1/2)</p>		

Q.
No.

SCORING INDICATOR

SPLIT
UP
SCORESUB
TOTAL

TOTAL

$$T_{\max} = l w \tau_k \times \frac{d}{2} = l \frac{t}{2} \sigma_{ck} \times \frac{d}{2}$$

(1)

Induced shear stress in the key,

$$\tau_k = \frac{2T_{\max}}{l w d} = \frac{2 \times 4774.65 \times 10^3}{140 \times 20 \times 80}$$

$$= \underline{\underline{42.63 \text{ N/mm}^2}} \quad (1)$$

Induced crushing stress in the key,

$$\sigma_{ck} = \frac{4T_{\max}}{l b d} = \frac{4 \times 4774.65 \times 10^3}{140 \times 20 \times 80}$$

$$= \underline{\underline{85.26 \text{ N/mm}^2}} \quad (1)$$

The induced shear stress & crushing stress are less than permissible values. Hence design is safe.

9

VI
b. Diameter ratio, $k = \frac{d_i}{d_o} = \frac{60}{120} = 0.5$ (1)

Torque Transmitted,

$$T = \frac{\pi}{16} z d_o^3 (1 - k^4) \quad (1)$$

$$= \frac{\pi}{16} \times 40 \times 120^3 (1 - 0.5^4)$$

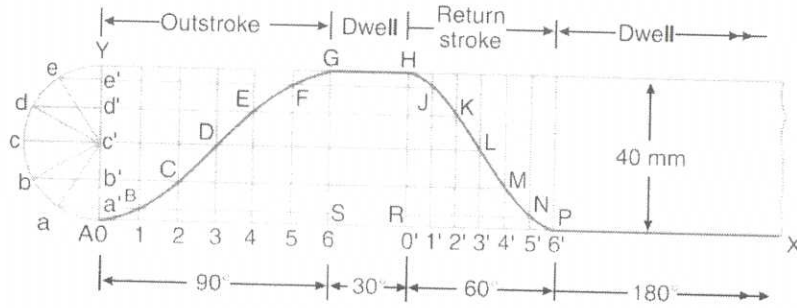
$$= \underline{\underline{12723450 \text{ Nmm}}} = \underline{\underline{12723.45 \text{ Nm}}} \quad (1)$$

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
	Power transmitted by the shaft, $P = \frac{2\pi NT}{60} = \frac{2\pi \times 100 \times 12723.45}{60}$ $= \underline{\underline{133.24 \text{ kW}}}$	(2) (1)	6	
<u>VII</u>	a.			
	Rubbing velocity, $v = \frac{\pi dN}{60}$ $= \frac{\pi \times 400 \times 10^{-3} \times 1500}{60}$ $= \underline{\underline{31.41 \text{ m/s}}}$	(1) (1)	5	
	Power wasted in friction, $P = \mu W v$ $= 0.03 \times 2500 \times 31.41$ $= 2355.75 \text{ W} = \underline{\underline{2.356 \text{ kW}}}$	(1) (1)		

Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
	Power transmitted by the shaft, $P = \frac{2\pi NT}{60} = \frac{2\pi \times 100 \times 12723.45}{60}$ $= \underline{\underline{133.24 \text{ kW}}}$	(2) (1)	6	
VII a.	Rubbing velocity, $v = \frac{\pi dN}{60}$ $= \frac{\pi \times 400 \times 10^{-3} \times 1500}{60}$ $= \underline{\underline{31.41 \text{ m/s}}}$	(1) (1) (1)	5	
	Power wasted in friction, $P = \mu W v$ $= 0.03 \times 2500 \times 31.41$ $= 2355.75 \text{ W} = \underline{\underline{2.356 \text{ kW}}}$	(1) (1)		

VII.b

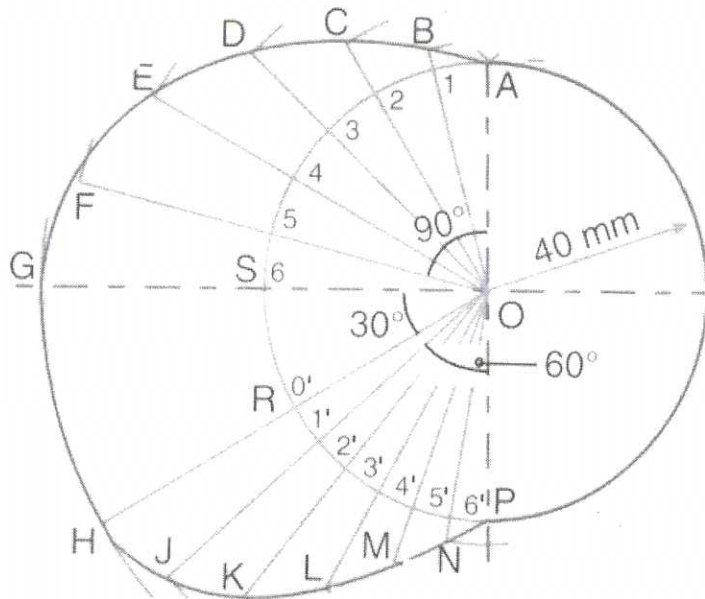
DISPLACEMENT DIAGRAM



4

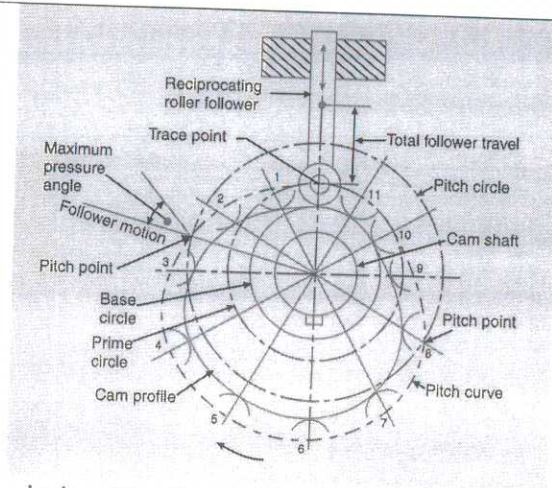
10

CAM PROFILE



6

VIII.a



1. Base circle : It is the smallest circle that can be drawn to the cam profile
2. Trace point : It is a reference point on the follower and is used to generate the pitch curve.
3. Pressure angle : It is the angle between the direction of the follower motion and a normal to the pitch curve.
4. Pitch point : It is a point on the pitch curve having the maximum pressure angle.
5. Pitch circle : It is a circle drawn from the centre of the cam through the pitch points.
6. Pitch curve : It is the curve generated by the trace point as the follower moves relative to the cam.
7. Prime circle :It is the smallest circle that can be drawn from the centre of the cam and tangent to the pitch curve.
8. Lift or stroke :It is the maximum travel of the follower from its lowest position to the topmost position.

5

9

4(any
4
terms)

VIII.b

- 1.The flywheel limits the inevitable fluctuations of speed during 'each cycle', which arise from fluctuations of turning moment on the crankshaft. The governor controls the 'mean' speed of the engine by varying the fuel supply to the engine.
2. The flywheel has no influence on the 'mean' speed of the engine. It does not maintain a constant speed. The governor has no influence on 'cyclic' speed fluctuations.
3. If the load on the engine is constant, the mean speed will be constant from cycle to cycle and the governor will not operate. On the other hand, the flywheel will be always acting. The operation of flywheel is continuous while that of governor is more or less intermittent.
- 4.A flywheel may not be used if the cyclic fluctuations of energy output are small or negligible. A governor is essential for all types of engines to adjust the fuel supply as per the demand.
- 5.The kind of energy stored in flywheel is kinetic energy. The kinetic energy is all available, 100% convertible into work without friction. The governor mechanism involves frictional losses.

6

6

(Any
3
points)

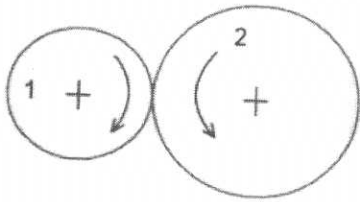
Q. No.	SCORING INDICATOR	SPLIT UP SCORE	SUB TOTAL	TOTAL
IX a.	<p>Power Transmitted, $P = (T_1 - T_2) V$</p> $\frac{T_1}{T_2} = e^{\mu\theta}, \quad T_2 = \frac{T_1}{e^{\mu\theta}}$ $\therefore P = T_1 \left(1 - \frac{1}{e^{\mu\theta}}\right) \frac{\pi d N}{60}$ <p>Angle of lap, $\theta = 160^\circ = 160 \times \frac{\pi}{180} = 2.79$ rad.</p> $\therefore P = 3 \times 10^3 \left(1 - \frac{1}{e^{0.25 \times 2.79}}\right) \frac{\pi \times 800 \times 10^3 \times 300}{60}$ $= \underline{\underline{18931.2 \text{ W}}} = \underline{\underline{18.93 \text{ kW}}}$	(1) (1) (2) (1) (2) (1)	8	
IX b	<p>(a) <u>open belt drive.</u></p> $L_o = \frac{\pi}{2} (d_2 + d_1) + 2c + \frac{(d_2 - d_1)^2}{4c}$ $= \frac{\pi}{2} (800 + 400) + (2 \times 5 \times 10^3) + \frac{(800 - 400)^2}{4 \times 5 \times 10^3}$ $= 11892.95 \text{ mm} = \underline{\underline{11.89 \text{ m}}}$ <p>(b) <u>cross belt drive.</u></p> $L_c = \frac{\pi}{2} (d_2 + d_1) + 2c + \frac{(d_2 + d_1)^2}{4c}$	(1 1/2) (1) (1) (1 1/2)	(7)	

$$= \frac{\pi}{2} (800 + 400) + (2 \times 5 \times 10^3) + \frac{(800 + 400)^2}{4 \times 5 \times 10^3}$$

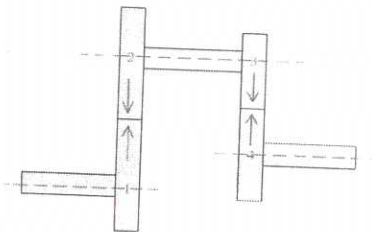
$$= 11956.95 \text{ mm} = \underline{11.96 \text{ m}}$$

X a.

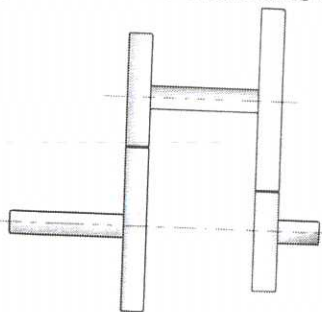
Simple gear train: Each shaft is mounted with one gear



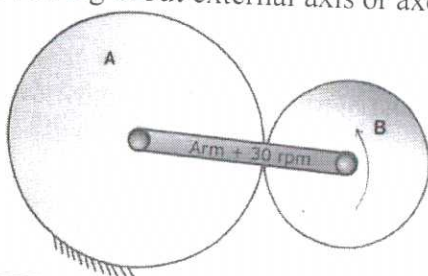
Compound gear train: In compound gear trains, at least one pair of gears is rigidly mounted on a same shaft, thus that pair has the same numbers of revolution.



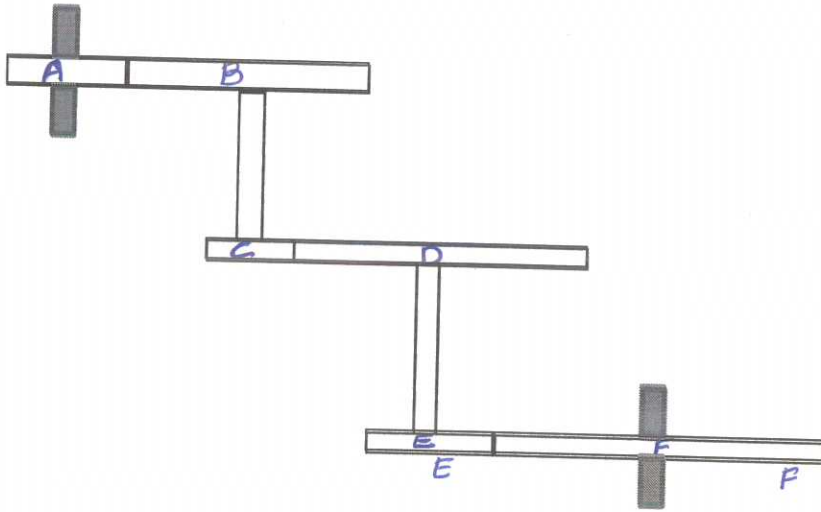
Reverted gear train: In a reverted gear train, the first and the last gears have the same axis of rotation.



Epicyclic gear train: Epicyclic gear train is the one in which the axes of some of the gears have motion. The said gear(s) would be revolving about external axis or axes.



Xb



$$\frac{N_F}{N_A} = \frac{T_A \times T_C \times T_E}{T_B \times T_D \times T_F}$$

$$N_F = \frac{T_A \times T_C \times T_E}{T_B \times T_D \times T_F} \times N_A$$

$$= \frac{30 \times 20 \times 25}{60 \times 75 \times 70} \times 1000$$

$$= 47.62 \text{ RPM (Counter clock wise)}$$

2

2

1

2

7