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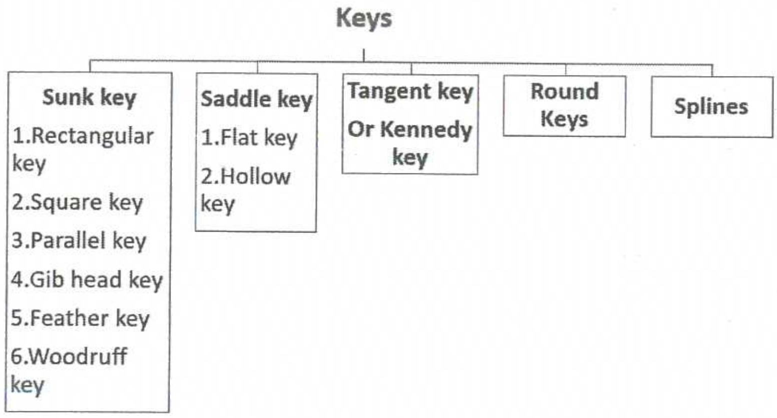
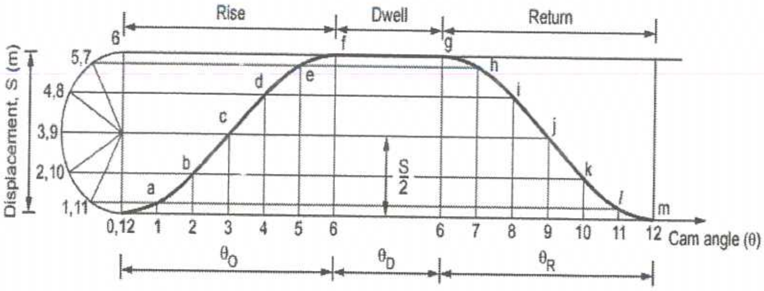
April -2024

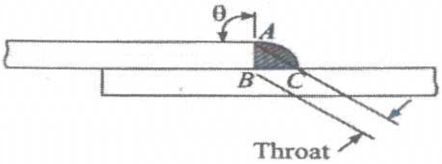
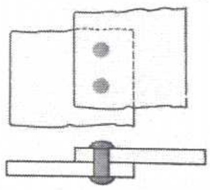
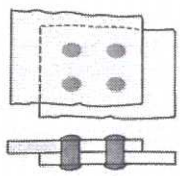
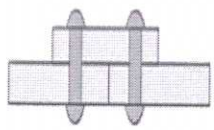
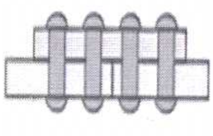
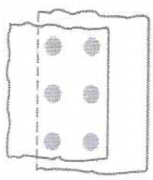
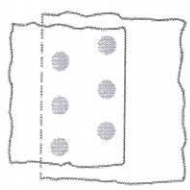
Scoring Indicators

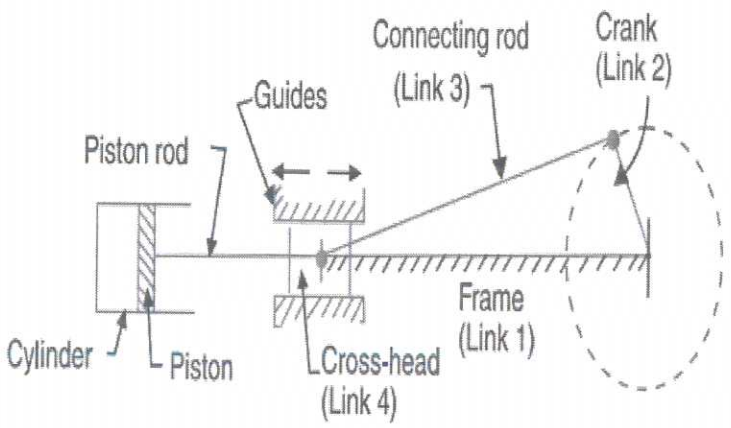
COURSE NAME: DESIGN OF MACHINE ELEMENTS

COURSE CODE: 5021 **QID :2109230029**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	Inversion of the mechanism		1	
I. 2	Major diameter		1	
I. 3	5 m, 6 m and 7 m		1	
I. 4	Connect Shaft and pulley or shaft and gear together to prevent relative motion between them		1	
I. 5	Period during which the follower remains stationary during some finite rotation of cam		1	
I. 6	Governor		1	
I. 7	Cams		1	
I. 8	Ratio of the pitch circle diameter in millimeters to the number of teeth. $m = \frac{D}{T}$		1	
I. 9	Train value $= \frac{Speed\ of\ driven}{Speed\ of\ driver} = \frac{No.of\ teeth\ on\ driver}{No.of\ teeth\ on\ driven}$	1 x 1	1	
	PART B			24
II. 1	Strength, Cost, Reliability, Shape, Size, Friction, Corrosion, Service life, Safety, Weight, Control, Existing products 'Maintenance, Thermal consideration, Styling, Stiffness, Wear, Lubrication	6 x 0.5	3	3
II. 2	Given: Torque ,$T = 10$ kN.m $= 10 X 10^6$ N.mm Shear stress, $\tau = 45$ Mpa $= 45$ N/mm^2 Torque , $T = \frac{\pi}{16} x \tau x D^3$ $10 X 10^6 = \frac{\pi}{16} x 45 x d^3$ $d^3 = \frac{10 X 10^6 x16}{\pi x 45} = 1131768.484$ d = 104.2 mm = **110 mm**	Eqn.1 + Sol.2	3	3
II. 3		1x3	3	3

II. 4	Given : T = 30 kN.m = 30 x 10^6 N.mm, τ = 100 M Pa = 100 N/mm^2, θ= 1° = 1 x$\frac{\pi}{180}$ = 0.01745 rad,l = 1 m = 1000 mm ; C = 84 GPa = 84 × 10^3 N/mm^2 $\frac{T}{J} = \frac{C.\theta}{l}$ or $J = \frac{Tl}{C.\theta} = \frac{30 \times 10^6 \times 1000}{84 \times 10^3 \times 0.01745}$ =20466639.38mm^4 $J = \frac{\pi}{32} \times d^4$=20466639.38; d = 120.16 say **125 mm**	Eqn.1 + Solu.2	3	3
II. 5	<u>Prime mover shafts:</u> Shafts connected to the sources of power. E.g., engine shaft. <u>Transmission shafts</u>: Transmit power between the source and the machines absorbing power. Examples are Axle, Spindle, line shafts, counter shafts etc. Machine shafts: Shafts form integral part of the machine itself. Example: crank shaft	3 x 1	3	3
II. 6	The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed. The coefficient of fluctuation of speed is a limiting factor in the design of flywheel.	2+1	3	3
II. 7	It permits a relative motion between the contact surfaces of the members, while carrying the load Reduce friction and make rotation more smooth It locates rotating parts in correct position It bears load Providing the guide for moving components	1 x 3	3	3
II. 8	<u>Rigid coupling</u>: Used to connect two perfectly aligned shafts. Types:(1) Sleeve or muff coupling, (2) Clamp or split-muff or compression coupling (3) Flange coupling <u>Flexible coupling</u>: It is used to connect two shafts having both lateral and angular misalignment. Types (a) Bushed pin type coupling, (b) Universal coupling, and (c) Oldham coupling	1.5 x 2	3	3
II.9		1x3	3	3
II.10	• Not a positive drive, slip occurs • Low transmission efficiency. • Transmits less power • Cannot operate under adverse temperature and atmospheric conditions • Wear and tear more • Not suitable when centre distance between driver and driven shaft is more	3 x1	3	3

	PART C			42
III.	1.<u>Leg of weld:</u> The side containing the right angle are called legs of the weld. The side AB and BC are called the legs of the weld 2.<u>Size of fillet weld</u>: The minimum length of the leg of a weld is called size of the weld 3.<u>Throat thickness</u>: It is the perpendicular distance between corner and hypotenuse of the weld cross section. The reinforcement is not included in throat thickness 	Fig2 + Exp5	7	7
IV.	**Lap joint:** One plate overlaps the other and the two plates are then riveted together Single riveted lap joint: Only one row of rivets is used for connecting two plates Double riveted lap joint: Two rows of rivets are used for connecting two plates **Butt joint**: Edges of two plates butt (i.e. touch) against each other and a cover plate (i.e. strap) is placed either on one side or on both sides of main plates. Cover plate is then riveted together with both the plates. Single riveted butt joint :Single row of rivet on each side of the joint Double riveted butt joint: Two rows of rivet on each side of the joint **Chain riveted: Every** rive of a row is opposite to the other rivet of the other row **Zig-Zag riveted: Every** rivet is in the middle of the two rivets of the opposite row Single riveted lap  Double riveted lap  Single riveted single cover butt  Double riveted single cover butt  Chain riveted  Zig Zag riveted 	Fig.3 + Exp.4	7	7

<table>
<tr>
<td>V.</td>
<td>It is the modification of four bar chain
It consist of one sliding pair and three turning pairs
Links 1 and 2 form one turning pair, links 2 and 3 form second turning pair, links 3 and 4 form third turning pair,
Links 4 and 1 form a sliding pair
It is found in reciprocating steam engine mechanism
This mechanism converts rotary motion into reciprocating motion and vice versa
The link 1 corresponds to the frame of the engine, which is fixed.
Link 2 is the crank, link 3 is the connecting rod and link 4 is the cross-head.
As the crank rotates, the cross-head reciprocates in the guides and thus the piston reciprocates in the cylinder.

</td>
<td>Fig3
+
Exp 4</td>
<td>7</td>
<td>7</td>
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<td>VI</td>
<td>Given : w = 75 mm ; t = 12.5 mm ; σ_t = 70 MPa = 70 N/mm^2 ; τ = 56 MPa = 56 N/mm^2.
Effective length of weld (l_1) for the transverse weld =
75 – 12.5 = 62.5 mm
Let l_2 = Length of each parallel fillet weld
Maximum load which the plate can carry is P = Area × Stress
= 75 × 12.5 × 70 = 65625 N
Load carried by single transverse weld, $P_1 = 0.707\ s \times l_1 \times \sigma_t$
= 0.707 × 12.5 × 62.5 × 70 = 38664 N
Load carried by double parallel fillet weld,
$P_2 = 1.414\ s \times l2 \times \tau = 1.414 \times 12.5 \times l_2 \times 56 =$ 990 x l_2 N
Load carried by the joint
$P = P_1 + P_2$
65625 = 38664 + 990 x l_2
or l_2 = 27.2 mm; Adding 12.5 mm for weld run
l_2 = 27.2 + 12.5 = 39.7 mm</td>
<td>Eqn.3
+
Solu.4</td>
<td>7</td>
<td>7</td>
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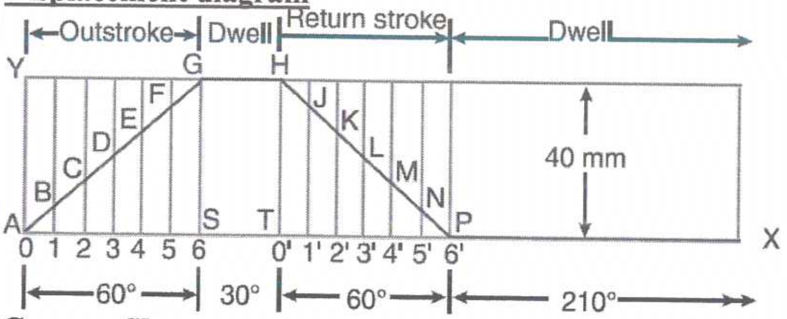
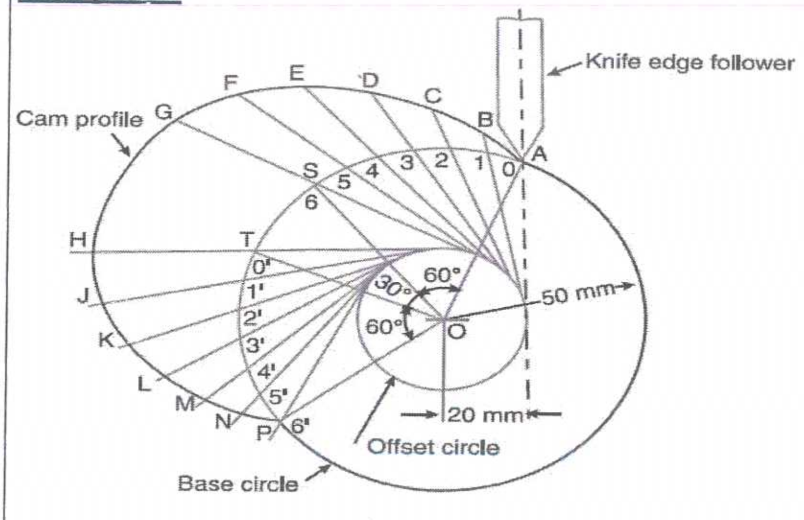
<tr><td>VII.</td><td>Given: P = 200 KW = 200 x 10^3 W,N = 80 r.p.m. , τ =60 N/mm^2 , d_i = 0.6 d_0
Power, $P = \frac{2\pi NT}{60}$ or $T = \frac{60P}{2\pi N} = \frac{60 \text{ x } 200 \text{ x } 103}{2\pi \text{x } 80}$ = 23873.2 N.m = 23873.2 x 10^3 N.mm
Torque , $T = \frac{\pi}{16} \text{ x } \tau \text{ x } d_o^3 \left[1 - (k)^4\right]$; $k = \frac{d_i}{d_o} = \frac{0.6 \text{ d}_0}{\text{d}_0} = 0.6$
$23873.2 \text{ x } 10^3 = \frac{\pi}{16} \text{ x } 60 \text{ x } (d_0)3\text{x} \left[1 - 0.6^4\right]$
$d_o^3 = \frac{23873.2 \text{ x } 103 \text{ x } 16}{\pi \text{ x } 60 \text{ x } 0.8704} = 2328148.154$
External diameter, d_0 = 132.5mm say 140 mm
Internal diameter, d_i= 0.6 x 140 = 0.6 x 140 = 84 mm</td><td>Eqn.2
+
Solu. 5</td><td>7</td><td>7</td></tr>
<tr><td>VIII.</td><td><u>Given</u>
d=50 mm; N = 3000 rpm; P = 150 kW = 150 x 10^3 W; l =75 mm; w= 16 mm; t= 10 mm
$P = \frac{2\pi NT}{60}$;$T = \frac{60P}{2\pi N} = \frac{60 \text{ x } 150 \text{ x } 10^3}{2\pi \text{ x } 3000}$ = 477.465 x 10^3 N.mm
Considering shear stress, $T = l \text{ x } w \text{ x } \tau \text{ x } \frac{d}{2}$
$\therefore \tau = \frac{T}{l \text{ x } w \text{ x} \frac{d}{2}} = \frac{477.465 \text{ x}10^3}{75 \text{ x } 16 \text{ x } 25}$ =15.9 N/mm^2
Considering crushing stress, $T = l \text{ x } \frac{t}{2} \text{ x } \sigma_C \text{ x } \frac{d}{2}$
$\therefore \sigma_C = \frac{T}{l \text{ x} \frac{d}{2} \text{x} \frac{t}{2}} = \frac{477.465\text{x}103}{75 \text{ x} \frac{50}{2} \text{x} \frac{10}{2}}$ = 50.9 N/mm^2</td><td>Eqn.3
+
Solu.4</td><td>7</td><td>7</td></tr>
<tr><td>IX.</td><td><u>Displacement diagram</u>


<u>Cam profile</u>

</td><td>3+4</td><td>7</td><td>7</td></tr>
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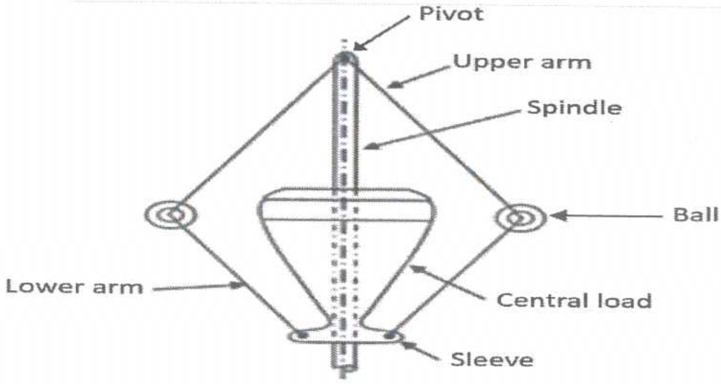
X.	• Porter governor is a modification of a Watt's governor, with central load attached to the sleeve as shown in Fig.  • It consists of two masses called the governor balls attached to the spindle with the help of four links or arms. • The lower arms are attached to the sleeve which acts as a central weight. • Governor balls rotate about the axis of the governor shaft which is driven through suitable gearing from the engine crankshaft. • If the engine speed increases due to decrease of load, the governor balls fly outwards and the sleeve moves upwards thus closing fuel passage till the engine speed comes back to its designed speed. • If the engine speed decreases due to increase of load, the governor balls move inward and the sleeve moves downwards thus opening the fuel passage more till the engine speed comes back to its designed speed.	Fig3 + Exp.4	7	7
XI.	Given Diameter of driver Pulley , d_1 = 800 mm Distance between the Pulleys, x = 5m = 5000 mm Diameter of driver pulley, d_2 = 400 mm **Case 1: for open belt** Length of belt ,L= $\pi(r_1+r_2) + 2x + \frac{(r_1-r_2)^2}{x}$ $= \pi(400+200) + 2x\ 5000 + \frac{(400-200)^2}{5000} =$ 11892.95 mm or **11.89 m** **Case 2: for cross belt** Length of belt ,L= $\pi(r_1+r_2) + 2x + \frac{(r_1+r_2)^2}{x} = \pi(400+200) + 2x$ $5000 + \frac{(400+200)^2}{5000}$ =11956.95 mm = **11.96 m**	Eqn.2 + Solu.5	7	7

<table>
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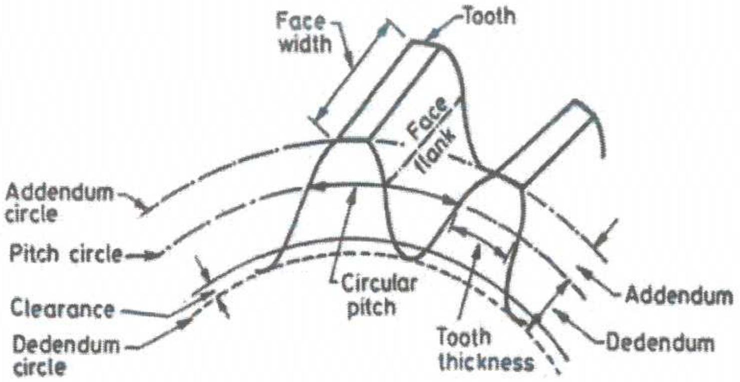
<td>XII.</td>
<td>

- Pitch circle. It is an imaginary circle which by pure rolling action, would give the same motion as the actual gear
- Addendum. It is the radial distance of a tooth from the pitch circle to the top of the tooth.
- Dedendum. It is the radial distance of a tooth from the pitch circle to the bottom of the tooth
- Circular pitch. 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 toot
- Clearance. It is the radial distance from the top of the tooth to the bottom of the tooth, in a meshing gear



</td>
<td>Fig.4
+
Exp.3</td>
<td>7</td>
<td>7</td>
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<td>XIII.</td>
<td>

Given: N_1= 120 rpm, d_1= 2000 mm, d_2= 1000 mm, t=5mm,S = 3%

<u>Case 1: No slip</u>

$\frac{N_2}{N_1} = \frac{d_1+t}{d_2+t}$

$\frac{N_2}{120} = \frac{2000+5}{1000+5}$

N_2= 239.4 rpm

<u>Case 2:Slip 3%</u>

$\frac{N_2}{N_1} = \frac{d_1+t}{d_2+t}\left(1 - \frac{S}{100}\right)$

$\frac{N_2}{120} = \frac{2000+5}{1000+5}\left(1 - \frac{3}{100}\right)$

N_2= 232.22 rpm
</td>
<td>(Eqn.1
+
Sol.2.5)
x 2</td>
<td>7</td>
<td>7</td>
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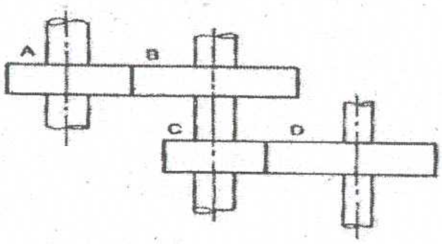
<td>XIV.</td>
<td>

$\frac{N_D}{N_A} = \frac{T_A \times T_C}{T_B \times T_D}$;$N_D = \frac{25 \times 35}{50 \times 70}$ x 300 = **75 rpm**



Direction of rotation of gear D is **clockwise**
</td>
<td>Fig.2
+
Eqn.1
+
Sol.4</td>
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<td>7</td>
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