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Subject Code

- Any -

Question Type

- Any -

marks

- Any -

Question Number

- Any -

Sub Number

- Any -

Apply

Examination: 2017 SUMMER

Que.No	Question/Problem	marks	Link
Q 5 c)	Question: **A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter running at 250 rpm. The angle of contact is 165o and the co-efficient of friction between the belt and the pulley is 0.35. If the safe working stress for the leather belt is 2 MPa, density of leather is 1050 kg/m3 and the thickness of belt is 10 mm, determine the width of belt, taking centrifugal tension into account.** **Answer:** We know that velocity of the belt, $v = \frac{\pi . d . N}{60} = \frac{\pi \times 1.2 \times 250}{60} = 15.71\ m/s$ and Power Transmitted (P) $P = (T_1 - T_2) v$ $7.5 \times 10^3 = (T_1 - T_2) 15.71$ $\therefore T_1 - T_2 = 7500/15.71 = 477.4\ N$ ......(i) We know that $\frac{T_1}{T_2} = e^{\mu \theta}$ $\therefore \frac{T_1}{T_2} = e^{0.35 \times 165 \times \pi/180}$ $\therefore \frac{T_1}{T_2} = 2.75$ ......(ii) from eqn (i) and (ii) $T_1 = 751.8\ N$, and $T_2 = 274.4\ N$ We know that mass of the belt per meter length, $m = \text{Area} \times \text{length} \times \text{density} = b t l \rho$ $= b \times 0.01 \times 1 \times 1050 = 10.5 b\ kg$ $\therefore$ Centrifugal Tension, $T_c = m . v^2 = 10.5 b (15.71)^2 = 2591.44 b\ N$ and Max. Tension in the belt, $T = \sigma . b . t = 2 \times 10^6 \times b \times 0.01$ $= 20000 b\ N$ We know that, $T = T_1 + T_c$ $\therefore 20000 b = 751.8 + 2591.44 b$ $\therefore 20000 b - 2591.44 b = 751.8$ $\therefore 17408.56 b = 751.8$ $\therefore b = \frac{751.8}{17408.56}$ $\therefore b = 0.04319\ m$ $\simeq 43.19\ mm.$	8	view

Examination: 2016 SUMMER

Que.No	Question/Problem	marks	Link
Q 5 c)	Question: **Two parallel shafts, connected by a crossed belt, are provided with pulleys 480 mm and 640 mm in diameters. The distance between the centre lines of the shafts is 3 m. Find by how much the length of the belt should be changed if it is desired to alter the direction of rotation of the driven shaft.** **Answer:** $D_1 = 480mm = 0.48m$ $R_1 = 0.24m$ $D_2 = 640mm = 0.64m$ $R_2 = 0.32m$ $x = 3m$ Crossed belt= $L = \Pi(r_1 + r_2) + 2x + \frac{(r_1 + r_2)^2}{l}$ ------------------------------------**1 mark** $L = \Pi(0.24 + 0.32) + 2(3) + \frac{(0.24 + 0.32)^2}{3}$ $L = 7.863mm$ --**2 marks** Now Rotation Alter(open belt) $L = \Pi(r_1 + r_2) + 2x + \frac{(r_1 - r_2)^2}{l}$ -----------------------------------**1 mark** $L = \Pi(0.24 + 0.32) + 2(3) + \frac{(0.24 - 0.32)^2}{3}$ $L = 7.76mm$ --**2 marks** **Length of belt should be changed,** L=(Length of cross belt)-(length of open belt) =7.863-7.76 **L=0.103 mm** --**2 marks**	8	view

<table>
<tr><th>Que.No</th><th>Question/Problem</th><th>marks</th><th>Link</th></tr>
<tr><td>Q 6 b)</td><td>

Question:

A simple band brake shown in figure 2 is applied to a shaft carrying a flywheel of mass 250 kg and of radius of gyration 300 mm. The shaft speed is 200 rpm. The drum diameter is 200 mm and the coefficient of friction is 0.25. The dimensions a and l are 100 mm and 280 mm respectively and the angle β = 135o. Determine
(i) the brake torque when a force of 120 N is applied at the lever end.
(ii) the number of turns of the flywheel before it comes to rest.
(iii) the time taken by flywheel to come to rest.

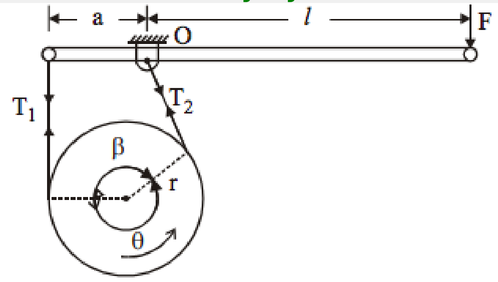
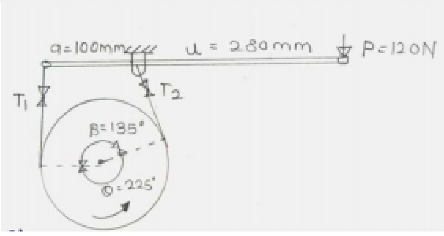


Fig. – 2

Answer:
A simple band brake drum:



Sol Given:- P = 120 N
N = 200 rpm
D = 200 mm = 0.2m
θ = 225° = 3.92 rad
K = 0.3m
a = 100 mm = 0.1m
l = 280 mm = 0.28m
μ = 0.25

Ans:-

$\frac{T_1}{T_2} = e^{\mu\theta}$ $\frac{T_1}{T_2} = e^{(0.25)(3.92)}$ $\frac{T_1}{T_2} = 2.669$ ----------------**01 mark**

$P = \frac{T_2 X x}{u} = 120 = \frac{T_2 X 0.1}{0.28}$

$T_2 = 336 N$ ----------------**01 mark**

$T_1 = T_2 X 2.669$

$T_1 = 336 X 2.669$; $T_1 = 896.784 N$ ----------------**01 mark**

$T_B = (T_1 - T_2)R$, $T_B = (896.784 - 336)0.1$

$T_B = 56 N.m$ ----------------**01 mark**

1) K. E. of Flywheel:-

$\frac{1}{2} I \omega^2 = \frac{1}{2} X (mk^2)\left(\frac{2 \Pi N}{60}\right)^2$

$= \frac{1}{2} X (250 X 0.3^2)\left(\frac{2 X \Pi X 200}{60}\right)^2$

$= \frac{1}{2} X 22.5 X 438.64$; K. E. = 4934.80 N. m------------------**02 mark**

Let n = Number of revolution before it comes to rest

Work done = $T_b X \theta = T_b X 2 X \Pi X n$

$= 56.07 X 2 X \Pi X n$

$= (352.298 X n)$ N.m --------**1 mark**

Work done = change in K. E.

$n = \frac{4934.80}{352.298}$; $n = 14.007$ ------------------**1 mark**

</td><td>8</td><td>view</td></tr>
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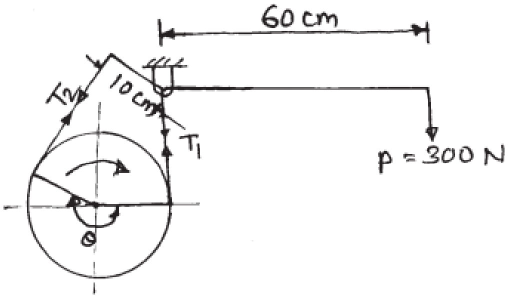
Que.No	Question/Problem	marks	Link
Q 6 c)	Question: **A conical pivot with angle of cone as 100o, supports a load of 18 kN. The external radius is 2.5 times the internal radius. The shaft rotates at 150 rpm. If the intensity of pressure is to be 300 kN/m2 and coefficient of friction as 0.05, what is the power lost in working against the friction ?** **Answer:** **Given data,** $2\alpha = 100^0$ $\alpha = 50^0$ $W = 18\,KN$ $P_{max} = 300 X 10^3\ N/m^2$ $\mu = 0.05$ $N = 150\,rpm$ $R_1 = 2.5 R_2$ $W = P X \Pi (R_1^2 - R_2^3)$ **------------------------1 mark** $18 X 10^3 = 300 X 10^3 (3.142)((2.5R_2)^2 - (R_2)^2$ $0.019 = 1.5 R_2^2$ $R_2 = 0.11\,m$ **------------------1 mark** $R_1 = 2.5 X 0.11$; $R_1 = 0.281 m$ **------------------1 mark** $\therefore T = \frac{2}{3} \mu W \frac{(R_1^3 - R_2^3)}{(R_1^2 - R_2^2) \sin\alpha}$ **------------------2 marks** $\therefore T = \frac{2}{3} \frac{0.05 X 18 X 10^3 ((0.281)^3 - (0.11)^3)}{((0.281)^2 - (0.11)^2) \sin 50^0}$ $T = \frac{16.336}{((0.281)^2 - (0.11)^2)}$ $T = 244.33\,N.m$ **------------------1 mark** $P = \frac{2 \Pi N T}{60} = \frac{2 X \Pi X 150 X 244.33}{60} = 3.837 X 10^3$ Watt $= 3.837$ K Watt **Power Lost = 3.837 KW------------------2 marks**	8	view

Examination: 2016 WINTER

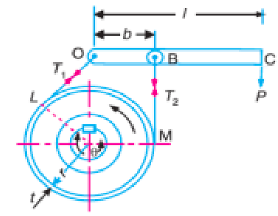
Que.No	Question/Problem	marks	Link
Q 5 a)	Question: **In a slider crank mechanism the length of crank and connecting rod are 100mm and 40mm respectively. The crank rotates uniformly at 600 rpm clockwise. Then crank has turned through 45° from I.D.C. Find by analytical method. (i) Velocity and acceleration of slider (ii) Angular velocity and angular acceleration of connecting rod.** **Answer:** Radius of crank , r=100 mm = 0.1m speed. N= 600 rpm , $\omega = 2\pi N/60 = 62.83$ rad/sec Length of connecting rod, l=400 mm=0.4m (40 mm is printing mistake) Obliquity ratio, n=l/r =400/100= 4, Crank angle , $\theta = 45^o$ Velocity of slider Vp= $\omega r(\sin\theta + \frac{\sin 2\theta}{2n})$ =5.225 m/s Acceleration of slider fp = $\omega^2 r(\cos\theta + \frac{\cos 2\theta}{n})$ =279.15 m/s^2 Angular velocity of connecting rod $\omega_{pc} = (\omega \cos\theta)/n$ = 11.107 rad/sec Angular acceleration of connecting rod $\alpha_{pc} = (-\omega^2 \sin\theta)/n$ = -697.89 rad/sec^2 ***[Note- If student has taken l=40,(due to printing mistake in QP) which is practically not possible, but values of answers in that case will be Vp=12.29 m/s ;fp= 279.15 m/s^2; ω_{pc}=111.07 rad/sec; α_{pc}=6978.86 rad/s^2 , which may be acceptable.]***	8	view
Q 5 c)	Question: In a band and block brake shown in Fig. No. 1 has 14 blocks. Each block subtends an angle of 16°, and μ = 0.3. Tension on tight side is T_1 and that on slack side is T_2 when force of 300 N is applied at the end of lever, find braking torque and direction of rotation of drum required.  **Fig. No. 1** **Answer:** Band and block brake No. of blocks n=14 ; θ= 16° ; μ = 0.3 braking force= 300N $\frac{Tn}{To} = [\frac{1+\mu\tan\frac{\theta}{2}}{1-\mu\tan\frac{\theta}{2}}]^n$ =3.26 .... 4 M To X 10=300 X 60 ; To =1800 N ; Tn = 1800 X 3.26 = 5868 N Let r_b = radius of brake drum (Not given). If we consider it as 10 cm, r_b = (5868-1800) X 0.1 =406.8 N m 4M	8	view

Que.No	Question/Problem	marks	Link
Q 6 c)	Question: **Determine the power lost in a footstep bearing due to friction if a load of 15 kN is supported and the shaft is rotating at 100 r.p.m. The diameter of bearing is 15cm and coefficient of friction is 0.05.** **Assume :** **(i) Uniform wear condition** **(ii) Uniform pressure condition.** **Answer:** 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-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-m $= \frac{1}{2} \times 0.05 \times 15 \times 10^3 \times 0.075$ = 28.1 N-m ---- [2M] Power lost, $P = \frac{2 \pi N T}{60 \times 1000} = 0.294$ KW -- [2M]	8	view

Examination: 2015 SUMMER

Que.No	Question/Problem	marks	Link
Q 5 a)	Question: **In reciprocating engine the crank is 250 mm long and connecting rod is 1000 mm long. The crank rotate at 150 rpm. Find velocity and acceleration of piston and angular velocity and angular acceleration of connecting rod when the crank makes an angle of 30° to IDC. Use analytical method.** **Answer:** **Solution of problem on Reciprocating Engine :** Given : r = 250 mm = 0.25 m , l = 1000 mm = 1 m , $\theta = 30°$; $N = 150$ rpm $\omega = \pi \times 150 / 60 = 7.85$ rad/s **1. Velocity of piston** We know that ratio of the length of connecting rod and crank, $n = l / r = 1 / 0.25 = 4$ ∴ Velocity of the slider, $v_P = \omega r \left(\sin\theta + \frac{\sin 2\theta}{2n} \right) = 7.85 \times 0.25 \left(\sin 30 + \frac{\sin 60°}{2 \times 4} \right)$ m/s $= 1.19$ m/s **Ans.** and acceleration of the slider, $a_P = \omega^2 . r \left(\cos\theta + \frac{\cos 2\theta}{n} \right) = (7.85)^2 \times 0.25 \left(\cos 30° + \frac{\cos 60°}{4} \right)$ m/s^2 $= 15.27$ m/s^2 **Ans.** **2. Angular velocity & Angular acceleration of Con Rod** We know that angular velocity of the connecting rod, $\omega_{PC} = \frac{\omega \cos\theta}{n} = \frac{7.85 \times \cos 30°}{4} = 1.67$ rad/s **Ans.** and angular acceleration of the connecting rod, $\alpha_{PC} = \frac{\omega^2 \sin\theta}{n} = \frac{(7.85)^2 \times \sin 30°}{4} = 7.7$ rad/s^2 **Ans.**	8	view

Que.No	Question/Problem	marks	Link
Q 5 c)	Question: **A belt is required to transmit 10 kW from a motor running at 600 rpm. The belt is 12 mm thick and has a mass density 0.001 gm/mm3 . Safe stress in the belt is not to exceed 2.5 N/mm2 , diameter of the driving pulley is 250 mm whereas the speed of the driven pulley is 200 rpm. The two shafts are 1.25 m apart. The coefficient of friction is 0.25, determine** **(1) Angle of contact at driving pulley** **(2) The width of the belt** **Answer:** $P = 10 \times 10^3$ W, $N_1 = 600$ rpm, $d_1 = 250$ mm $= 0.25$ m $\mu = 0.25$, $x = 1.25$ m, $\rho = 0.001$ gm/mm^3 $\sigma = 2.5$ N/mm^2, $N_2 = 200$ rpm $\frac{N_1}{N_2} = \frac{d_2}{d_1}$ $\therefore d_2 = 0.75$ m $\therefore r_2 = 0.375$ m We have, $\sin\alpha = \frac{r_2 - r_1}{x} = \frac{0.375 - 0.125}{1.25}$ $\therefore \alpha = 11.53°$ $\therefore 2\alpha = 23.07°$ $\therefore$ Angle of lap $\theta = 180 - 2\alpha$ $= 156.9°$ $= 2.73$ rad Velocity $v = \frac{\pi d_1 N_1}{60} = 7.85$ m/sec Power $P = (T_1 - T_2) \cdot v$ $\therefore T_1 - T_2 = 1273.90$ ---- ① Also, $\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25 \times 2.73} = 1.97$ --- ② From eqn ① & ② $T_1 = 1313.3$ N & $T_2 = 667$ N Now, $T_1 = \sigma \times b \times t = 2.5 \times b \times 12$ $\therefore b = 43.77$ mm Note:- If prob is solved considering m & T_c, give full credit	8	view

Que.No	Question/Problem	marks	Link
Q 6 b)	Question: **A simple band brake is operated by lever 40 cm long. The brake drum diameter is 40 cm and brake band embrance 5/8 of its circumference. One end of band is attached to a fulcrum of lever while other end attached to pin 8 cm from fulcrum. The coefficient of friction 0.25. The effort applied at the end of lever is 500 N. Find braking torque applied if drum rotates anticlockwise and acts downwards.** **Answer:** $d = 0.4\,m,\ r = 0.2\,m,\ l = 0.4\,m,\ \mu = 0.25$ $\theta = \frac{5}{8} \times 360^\circ = 225^\circ = 3.92\ rad,\ b = 0.08\,m.$ We have, $\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25 \times 3.92} = 2.66$ ----(1) Braking Torque $T_B = (T_1 - T_2) \times r$ Taking moment about $P \times l = T_2 \times b$ $500 \times 0.4 = T_2 \times 0.08$ $\therefore T_2 = 2500\ N$ $\&\ T_1 = 6650\ N$ So, $T_B = (6650 - 2500) \times 0.2$ $= 830\ N\text{-}m.$  Anticlockwise rotation of drum.	8	[view]
Q 6 c)	Question: **An engine of a car has a single plate clutch developed maximum torque 147 N-m. External diameter of clutch plate is 1.2 times its internal diameter. Determine the dimension of clutch plate and axial force provided by the spring. The maximum pressure intensity of the clutch facing 98 kN/m2 and coefficient of friction is 0.3. Assume uniform wear condition.** **Answer:** Max. Torque $T = 147\ N\text{-}m,\ n = 2$ $d_1 = 1.2\,d_2,\ \mu = 0.3,\ P_{max} = 98 \times 10^3\ N/m^2$ uniform wear condition Mean rad. $R = \frac{r_1 + r_2}{2} = \frac{1.2\,r_2 + r_2}{2}$ $= 1.1\,r_2$ $T = n \mu W R = 2 \times 0.3 \times W \times 1.1\,r_2$ $\therefore W = 222.7\,r_2$ ------ (1) Also, $p \cdot r_2 = C \quad \therefore C = 98 \times 10^3\,r_2$ ----(2) But $W = 2\pi C (r_1 - r_2)$ $222.7\,r_2 = 2\pi \times 98 \times 10^3\,r_2 (1.2\,r_2 - r_2)$ $222.7 = 123088\,r_2$ $\therefore r_2 = 1.8\ mm$ $\&\ r_1 = 1.2 \times 1.8 = 2.1\ mm$ $W = 222.7 \times 1.8 \times 10^{-3}$ $= 0.40\ N$	8	[view]

Examination: [2015 WINTER]

Que.No	Question/Problem	marks	Link
Q 5 c)	Question: **Two parallel shafts whose centre line are 4.8 m apart, are connected by open belt drive. The diameter of larger pulley is 1.5 m and that of smaller pulley 1 m. The initial tension in the belt when stationary is 3 kN. The mass of the belt is 1.5 kg/m length. The coefficient of friction between the belt and pulley is 0.3 Taking centrifugal tension into account, calculate the power transmitted when the smaller pulley rotates at 400 rpm.** **Answer:** We know that velocity of the belt, $v = \frac{\pi d_2 . N_2}{60} = \frac{\pi \times 1 \times 400}{60} = 21 \text{m/s}$ and centrifugal tension, $T_C = m.v^2 = 1.5\,(21)^2 = 661.5\text{ N}$ Let T_1 = Tension in the tight side, and T_2 = Tension in the slack side. We know that initial tension (T_0), $3000 = \frac{T_1 + T_2 + 2T_C}{2} = \frac{T_1 + T_2 + 2 \times 661.5}{2}$ $\therefore$ $T_1 + T_2 = 3000 \times 2 - 2 \times 661.5 = 4677\text{ N}$ ...(*i*) For an open belt drive, $\sin\alpha = \frac{r_1 - r_2}{x} = \frac{d_1 - d_2}{2x} = \frac{1.5 - 1}{2 \times 4.8} = 0.0521$ or $\alpha = 3°$ $\therefore$ Angle of lap on the smaller pulley, $\theta = 180° - 2\alpha = 180° - 2 \times 3° = 174°$ $= 174° \times \pi / 180 = 3.04\text{ rad}$ We know that $2.3 \log\left(\frac{T_1}{T_2}\right) = \mu.\theta = 0.3 \times 3.04 = 0.912$ $\log\left(\frac{T_1}{T_2}\right) = \frac{0.912}{2.3} = 0.3965$ or $\frac{T_1}{T_2} = 2.5$ ...(*ii*) ...(Taking antilog of 0.3965) From equations (*i*) and (*ii*), $T_1 = 3341\text{ N}$; and $T_2 = 1336\text{ N}$ $\therefore$ Power transmitted, $P = (T_1 - T_2)\,v = (3341 - 1336)\,21 = 42\,100\text{ W} = 42.1\text{ kW}$ **Ans.**	8	[view]
Q 6 b)	Question: **In a simple band brake, the band acts on the 3/4th of circumference of a drum of 450 mm diameter which is keyed to the shaft. The band brake provides a braking torque of 225 N.m. One end of the band is attached to a fulcrum pin of the lever and the other end to a pin 100 mm from the fulcrum. It the operating force is applied at 500 mm from the fulcrum and the coefficient of friction is 0.25, find the operating force when the drum rotates in the** **(i) anticlockwise direction and** **ii) clockwise direction** **Answer:** We know that braking torque (T_B), $225 = (T_1 - T_2)\,r = (T_1 - T_2)\,0.225$ $\therefore$ $T_1 - T_2 = 225 / 0.225 = 1000\text{ N}$ . . . (*ii*) From equations (*i*) and (*ii*), we have $T_1 = 1444\text{ N}$; and $T_2 = 444\text{ N}$ Now taking moments about the fulcrum *O*, we have $P \times l = T_2.b$ or $P \times 0.5 = 444 \times 0.1 = 44.4$ $\therefore$ $P = 44.4 / 0.5 = 88.8\text{ N}$ **Ans.** *(b) Operating force when drum rotates in clockwise direction* When the drum rotates in clockwise direction, as shown in Fig. (*a*), then taking moments about the fulcrum *O*, we have $P \times l = T_1.b$ or $P \times 0.5 = 1444 \times 0.1 = 144.4$ $\therefore$ $P = 144.4 / 0.5 = 288.8\text{ N}$ **Ans.**	8	[view]

Que.No	Question/Problem	marks	Link
Q 6 c)	Question: **A single plate clutch with both sides effective has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed of 2500 rpm. Assume uniform condition.** **Answer:** **Single Plate Clutch:** Since the intensity of pressure (p) is maximum at the inner radius (r_2), therefore for uniform wear, $p.r_2 = C$ or $C = 0.1 \times 100 = 10$ N/mm We know that the axial thrust, $W = 2\pi C(r_1 - r_2) = 2\pi \times 10\,(150 - 100) = 3142$ N and mean radius of the friction surfaces for uniform wear, $R = \frac{r_1 + r_2}{2} = \frac{150 + 100}{2} = 125$ mm $= 0.125$m We know that torque transmitted, $T = n.\mu.W.R = 2 \times 0.3 \times 3142 \times 0.125 = 235.65$ N-m ...($\because n = 2$, for both sides of plate effective) $\therefore$ Power transmitted by a clutch, $P = T.\omega = 235.65 \times 261.8 = 61\,693$ W $= 61.693$ kW Ans.	8	view