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12. A punching press pieces 35 holes per minute in a plate using 16 kNm of energy per hole during each revolution. Each piercing takes 40% of the time needed to make one revolution. The punch receives power through a gear reduction unit which in turn is fed by a motor driven belt pulley 800 mm diameter and turning at 210 r.p.m. Find the power of the electric motor if overall efficiency of transmission unit is 80% Design a cast iron flywheel to be used with the punching machine for a coefficient of steadiness of 5, if the space considerations limit the maximum diameter to 1.3m.

Allowable shear stress in the shaft material = 50 MPa

Allowable tensile stress for cast iron = 4 MPa

Density of cast iron 7200 kg/m<sup>3</sup>

[15]

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**2014**

**Machine Design**

**Time Allotted : 3 Hours**

**Full Marks : 70**

**The figure in the margin indicate full marks.  
Candidates are required to give their answers in their own words as far as practicable**

**GROUP – A**

**Multiple choice type questions**

1. Choose the right option for any Ten of the following :

10X1=10

i) A multi disc clutch has 3 discs on driving shaft and 2 discs on driver shaft. Number of pairs of contact surface is -

(a) 5 (b) 2 (c) 3 (d) 4

ii) According to uniform wear theory the mean radius of the friction surface of a disc clutch is :

(a)  $\frac{2(r_1^3 - r_2^3)}{3(r_1^2 - r_2^2)}$

(b)  $\frac{(r_1 + r_2)}{2}$

(c)  $\frac{(r_1 - r_2)}{2}$

(d)  $\frac{2(r_1^3 + r_2^3)}{3(r_1^2 - r_2^2)}$

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- iii) If both the pinion and gear are made of same material then load carrying capacity is decided by :
- Gear
  - Pinion
  - None of these
  - Both (a) and (b)
- iv) The recommended semi cone angle of a cone clutch is :
- 12.5°
  - 22.5°
  - 45°
  - 70°
- v) If  $P$ =bearing pressure on projected bearing area,  $Z$ =absolute viscosity of the lubricant and  $N$ =speed of journal then bearing characteristic number is given by –
- $\frac{ZN}{P}$
  - $\frac{P}{ZN}$
  - $\frac{Z}{PN}$
  - $\frac{PN}{Z}$
- vi) A brake is said to be self energizing if –
- The direction of applied force is same as that of frictional force
  - The direction of moment due to frictional force and that due to external force is the same, required to operate the brake
  - no external force is required to operate the brake
  - an external force is required to disengage the brake

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- vii) The co-efficient of fluctuation of speed  $K_s$  is –
- difference between the maximum speed  $\omega_1$  and minimum speed  $\omega_2$
  - $2(\omega_1 - \omega_2) / (\omega_1 + \omega_2)$
  - $(\omega_1 + \omega_2) / 2(\omega_1 - \omega_2)$
  - $\omega_1 - \omega_2 / 2$
- viii) The designation M 33 X 2 of a bolt means
- metric threads of 33 Nos. in 2 cm
  - metric threads with cross-section of 33 mm<sup>2</sup>
  - metric threads of 33 mm pitch diameter and 2 mm pitch
  - bolt of 33 mm nominal diameter having 2 threads per cm.
- ix) For long shoe block brakes the equivalent coefficient of friction  $\mu'$  is related with the coefficient of friction of the friction lining  $\mu$  by the factor :
- $\frac{\sin \theta}{2\theta + \sin 2\theta}$
  - $\frac{\sin \theta}{\theta + \sin 2\theta}$
  - $\frac{4 \sin \theta}{2\theta + \sin 2\theta}$
  - $\frac{4 \sin \theta}{\theta + \sin 2\theta}$
- x) Herringbone gears are used to :
- avoid the effect of dynamic load
  - eliminate axial thrust
  - reduce the wear of teeth
  - avoid interference

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xi) In hydrodynamic lubrication, the friction is due to :

- (a) metal to metal contact
- (b) fluid shear
- (c) load on journal
- (d) none of these

xii) Coupling and clutch connect two shafts –

- (a) At rest
- (b) In motion
- (c) At rest and in motion respectively
- (d) All the above

**Group-B**

**(Short type answer questions)**

**Attempt any Three questions      3X5=15**

2. Classify main types of clutches and brakes.

A single plate friction clutch has an outer diameter of 200 mm and inner diameter as 100 mm. The distribution of normal pressure between the surface is  $C_1 + C_2/r$  where  $r$  is the general radius and  $C_1$  and  $C_2$  are constants. If the normal pressure at the inner radius is  $1/3^{\text{rd}}$  more than that at the outer radius, determine the torque transmitted with an axial thrust of 45 kg. The coefficient of friction between the surfaces is 0.3.

[5]

3. What is autofrettage? Describe compounding for pre-stressing the cylinder. [5]

4. A triple threaded worm has teeth of 5mm module and pitch circle diameter of 60mm. If the worm has 30 teeth find

- i) Lead angle
- ii) Velocity ratio and
- iii) centre distance of the worm gearing system [5]

5. Explain the terms 'backlash', 'interference', and 'undercut' in connection with gear. [5]

6. Explain the functional difference between flywheel and governor? [5]

7. A taper roller bearing has a dynamic load capacity of 30kN. The desired life of 90% bearing is 10000 hours and the speed is 1000rpm. Calculate the equivalent radial load the bearing can carry.

**Group – C**

**(Long Answer Type Questions)**

**Answer any Three of the following      3X15=45**

8. Derive Reynold's equation for hydrodynamically lubricated journal bearing and state the assumptions.

A full journal bearing of 50mm diameter and 100 mm long has a bearing pressure of  $1.4 \text{ N/mm}^2$ . The speed of the journal is 900rpm and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of  $75^\circ\text{C}$  may be taken as  $0.011 \text{ kg/ms}$ . The room temperature is  $35^\circ\text{C}$ . Find-

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(a) the amount of artificial cooling required and (b) the mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10oc. Take specific heat of the oil as 1850 j/kg k.

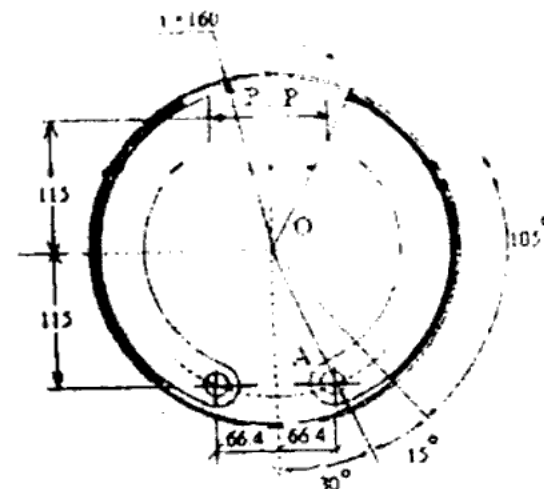
9. A pair of 20° full depth involute teeth bevel gears connects two shafts at right angle having velocity ratio 3:1. The gear is made of cast steel having allowable static stress as 70 MPa and the pinion is of steel with allowable static stress as 100 MPa. The pinion transmits 37.5 kW at 750 r.p.m. Determine –

- Module and face width
- Pitch diameter
- Pinion shaft diameter

Assume tooth form factor  $y = 0.154 - (0.912/T_g)$  where  $T_g$  is the formative number of teeth, width is  $1/3^{rd}$  of the length of pitch cone, and pinion shaft overhangs by 150 mm. (3X5)

10. An automobile type internal expanding double shoe brake is shown in fig1. Diameter of the brake drum is 320mm and the brake is actuated by a mechanism, which exerts equal force P on each shoe as shown in figure. Shoes are identical and having a face width of 50mm. lining is molded asbestors with  $\mu = 0.3$  and  $p_{max} = 1 \text{ N/mm}^2$ . Determine the braking capacity and the actuating force

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All dimensions are in mm

Fig. 1

11. A single row deep groove ball bearing is subjected to a radial load of 8 kN and a thrust load of 3 kN. The diameter of the shaft is 75 mm rotating at 1200 rpm. The bearing selected is 6315 for which the basic static capacity  $C_0 = 72 \text{ kN}$  and the basic dynamic capacity 'C' is 112 kN. The radial load factor and thrust factor X and Y are given below in the table. You are required to determine the expected rated bearing life.

$\frac{F_u}{C_0}$	$\frac{F_u}{F_r} \leq e$		$\frac{F_u}{F_r} > e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.040	1	0	0.56	1.8	0.24
0.070	1	0	0.56	1.6	0.27
0.130	1	0	0.56	1.4	0.31
0.250	1	0	0.56	1.2	0.37
0.500	1	0	0.56	1.0	0.44

X and Y factors for single - row deep groove ball bearings.