Q.P. Code: 25985

(Hours: 03) **Marks: 80**

Note:

1. Question **no.1** is compulsory.
2. Attempt any **three** questions from the remaining questions.
3. Assume suitable data wherever required.

1 Answer any four questions. **20**

(a) Sketch a pantograph, explain its working and show that it can be used to reproduce to an enlarged scale a given figure.

(b) What are straight line mechanisms? Describe one type of exact straight line motion mechanism with the help of a sketch.

(c) Establish an expression for the natural frequency of free transverse vibrations for a simply supported beam carrying a number of point loads, by Dunkerley's method.

(d) What is the significance of degrees of freedom of a kinematic chain when it functions as a mechanism? Give examples.

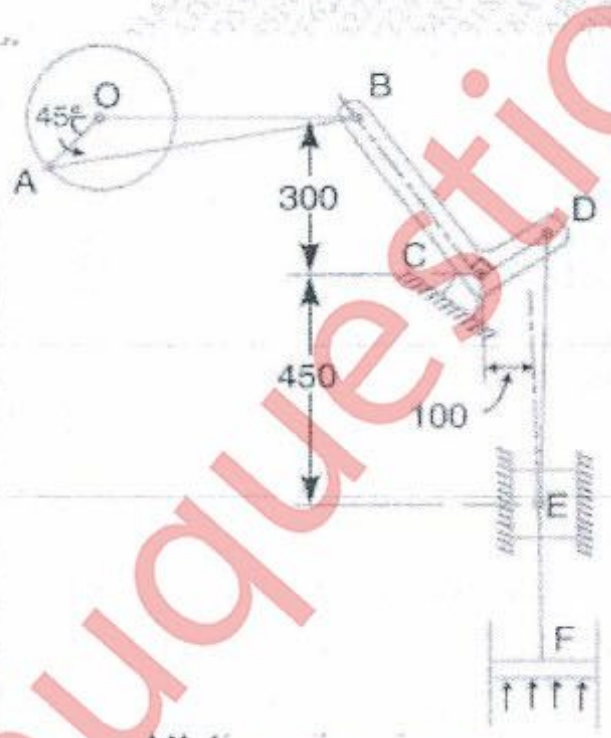
(e) State and prove the law of gearing. Show that involute profile satisfies the conditions for correct gearing.

(f) Describe the construction and operation of a prony brake or rope brake absorption dynamometer.

(g) Write a short note gyroscope.

2

(a) A pump is driven from an engine crank-shaft by the mechanism as shown in Fig.1. The pump piston shown at F is 250 mm in diameter and the crank speed is 100 r.p.m. The dimensions of various links are as follows: OA = 150 mm ; AB = 600 mm ; BC = 350 mm ; CD = 150 mm; and DE = 500 mm. Determine for the position shown : 1. The velocity of the cross-head E, 2. The rubbing velocity of the pins A and B which are 50 mm diameter. 3. The torque required at the crank shaft to overcome a presure of 0.35 N/mm^2, and 4. The acceleration of the cross-head E. **14**



All dimensions in mm

Fig1

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(b) Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. 2. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: 1. Velocity of the slider A,and 2. Angular velocity of the connecting rod AB. **6**

Fig2

3

(a) Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is $40x10^3$ kg/m^3, and Young's modulus is 200 GN/m^2. Assume the shaft to be freely supported. **5**

(b) A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below : **15**

1. To raise the valve through 50 mm during 120° rotation of the cam ;
2. To keep the valve fully raised through next 30°;
3. To lower the valve during next 60°; and
4. To keep the valve closed during rest of the revolution i.e. 150° ;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when the line of the stroke is offset 15 mm from the axis of the cam shaft.

4

(a) Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form; module = 6 mm, addendum = one module, pressure angle = 20°. The pinion rotates at 90 r.p.m. Determine: 1. The number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel, 2. The length of path and arc of contact, 3.The number of pairs of teeth in contact, and 4. The maximum velocity of sliding. **10**

(b) A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and $\mu = 0.3$; find the total spring load pressing the plates together to transmit 25 kW at 1575 r.p.m. If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces has worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear. **10**

5

(a) A shaft has three eccentrics, each 75 mm diameter and 25 mm thick, machined in one piece with the shaft. The central planes of the eccentric are 60 mm apart. The distance of the centres from the axis of rotation are 12 mm, 18 mm and 12 mm and their angular positions are 120° apart. The density of metal is 7000 kg/m3. Find the amount of out-of-balance force and couple at 600 r.p.m. If the shaft is balanced by adding two masses at a radius 75 mm and at distances of 100 mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions. **10**

(b) The speed ratio of the reverted gear train, as shown in Fig. 3, is to be 12. The module pitch of gears A and B is 3.125 mm and of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth. **10**

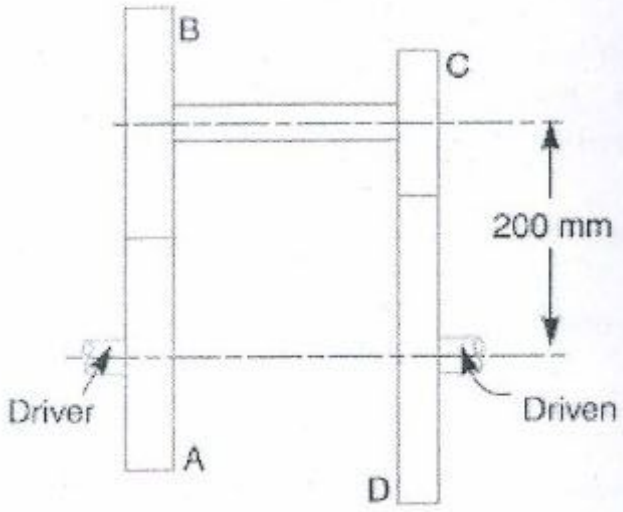
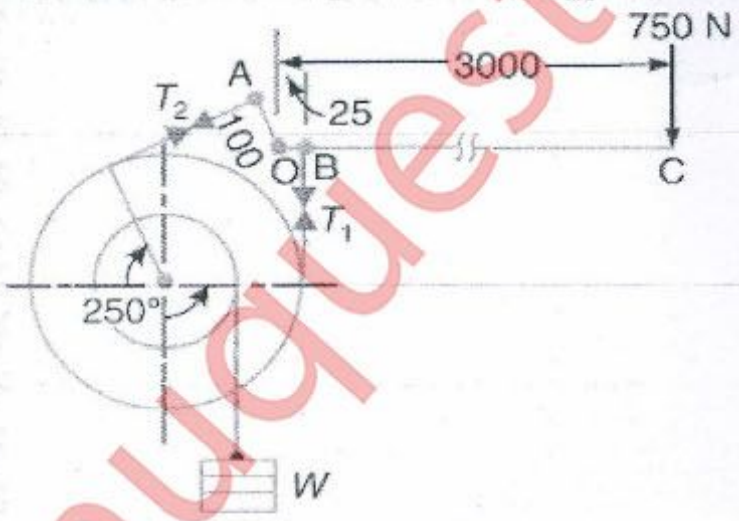


Fig3

6

(a) In a winch, the rope supports a load W and is wound round a barrel 450 mm diameter as shown in fig 4. A differential band brake acts on a drum 800 mm diameter which is keyed to the same shaft as the barrel. The two ends of the bands are attached to pins on opposite sides of the fulcrum of the brake lever and at distances of 25 mm and 100 mm from the fulcrum. The angle of lap of the brake band is 250° and the coefficient of friction is 0.25. What is the maximum load W which can be supported by the brake when a force of 750 N is applied to the lever at a distance of 3000 mm from the fulcrum ? **10**



All dimensions in mm.

Fig4

(b) A steel shaft 1.5 m long is 95 mm in diameter for the first 0.6 m of its length, 60 mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining 0.4 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 kg and 0.85 m radius of gyration located at the 95 mm diameter end and the second having a mass of 700 kg and 0.55 m radius of gyration located at the other end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as $80GN/m^2$. **10**

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