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2005 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

III B.TECH I SEMESTER SUPPLEMENTARY EXAMINATIONS
DYNAMIC OF MECHANICS
(MECHANICAL ENGINEERING)

NOVEMBER 2005

TIME: 3 HOURS
MAX MARKS: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Derive an expression for gyroscopic couple [6]

(b) An aeroplane makes a complete half circle of 60m radius, to the left when flying at 200 Kmph. The rotary engine and the propeller of the aeroplane weigh 4000N with a radius of gyration 30 cm the engine runs at 2500rpm CW, when viewed from rear. Find the gyroscopic couple on the aircraft and state its effect on it. Show gyroscopic effect by a sketch [10]

2. A single cylinder gas engine develops 250 kW at 270 r.p.m. The work done by the gases on the expansion stroke is 3.3 times to work done on the gases during compression stroke and the work done on the gases during suction and exhaust stroke is negligible. If the total fluctuation of speeds is not to exceed ± 2% of the mean speed, find the requirement of the inertia of the flywheel. Given the density of cast iron is 0.0072-kg/ cm3, and that the mean speed of the rim is not to exceed 1700 m/min. Calculate:
(a) Energy to be absorbed by the flywheel [6]

(b) The mass of the flywheel. Assume the shape of the turning moment diagram for a gas engine as a triangle on a base of radians. [10]

3. A band brake used for a winch is wound round a drum of 0.75 m diameter, keyed to the shaft. The two ends of the band are attached to the pins on the opposite sides of the fulcrum of the brake lever at distances of 25 mm and 100 mm from the fulcrum. The angle of lap on the drum is 2400. The coefficient of friction is 0.25. Find the torque which can applied by the brake when a force of 500 N applied to the lever upwards at a distance of 1 m from the fulcrum. Consider clockwise and counter-clockwise directions of rotation. [16]

4. (a) Derive an expression for minimum force required to slide down a body on a rough inclined plane.

(b) A centrifugal clutch has four shoes which slide radially in a spider keyed to the driving shaft driving shaft and make contact with the internal cylindrical surface of a rim keyed to the driven shaft. When the clutch is at rest, each shoe is pulled against a stop by a spring so as to leave a radial clearance of 5 mm between the v shoe and the rim. The pull exerted by the spring is then 600 N. The mass centre of the shoe is 160 mm from the axis of the clutch. If the internal diameter of the rim is 400 mm, the mass of each shoe is 8 kg, the stiffness of each spring is 50 N/mm and the coefficient of friction between the shoe and the rim is 0.3 find the power transmitted by the clutch at 500 r.p.m. [8+8]

5. The arms of a Hartnell governor are of equal length. At the mid position of the sleeve, the ball arm is vertical and the radius at which the ball rotates is 8.25cm when the equilibrium speed, neglecting friction, is 450rpm. On changing the speed by 1%, the governor is able to overcome the friction at this position. The friction force is assumed to have a constant value of 30N at the sleeve. The sleeve moves ±1.6cm from the mean position. The minimum speed of the governor including friction is 428 rpm. The mass of the sleeve is 3.5kg. Determine

(a) the magnitude of the rotating masses,

(b) the spring stiffness,

(c) the initial compression of the spring

(d) the maximum speed. [4*4]

6. In a four cylinder petrol engine equally spaced, the cranks numbered from the front end are 1,2,3 and 4. The cranks 1 and 4 are in phase and 1800 ahead of cranks 2 and 3. The reciprocating mass of each cylinder is l kg. The cranks are 50mm radius and the connecting rod 200mm long. What are the resultant unbalanced forces and couples, primary and secondary, when viewed from the front. Take the reference plane midway between cylinders 2 and 3. [16]

7. An air compressor has four vertical cylinders 1,2,3 and 4 inline and the driving cranks at 90 intervals reach their upper most positions in this order. The cranks are of 150mm radius, the connecting rods 500mm long and the cylinder centre line 400mm apart. The mass of the reciprocating parts of each cylinder is 22.5kg and the speed of rotation is 400r.p.m. Show that there are no out-of-balance primary or secondary forces and determined the corresponding couples, indicating the positions of No. 1 crank for maximum values. The central plane of the machine may be taken as reference plane. [16]

8. (a) Derive an equation for the transverse vibration of a uniformly loaded shaft.

(b) A rigid massless bar of length L is hinged at its end and carries a spring K2 with mass at its right end. The bar is also supported by a spring K1 at a distance from the left hinge. Determine the natural frequency of the bar [6+10]