B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination 01601

December, 2012

BIMEE-007 : ADVANCED DYNAMICS OF MACHINE

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **all five** questions. All questions carry **equal** marks. Use of scientific calculator is permitted.*

1. Answer ***any one*** of the following : **14**

(a) For a reciprocating engine, prove that the displacement, velocity and acceleration of the piston are given respectively by the following expression :

Displacement

$$x_p = r\left[(1-\cos\theta) + \left(n - \sqrt{n^2 - \sin^2\theta}\right)\right]$$

Velocity $V_P = wr\left(\sin\theta + \frac{\sin 2\theta}{2n}\right)$

Acceleration $a_p = w^2 r\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$

Where r = length of crank,

l = length of connecting rod, $n = \frac{l}{r}$,

and θ = Inclination of the crank to the inner dead centre position.

(b) The lengths of crank and connecting rod of a horizontal reciprocating engine are 100 mm and 500 mm respectively. The crank is rotating at 400 rpm. When the crank has turned 30° from the inner dead centre, find analytically :

(i) acceleration of the piston

(ii) velocity of the piston,

(iii) angular velocity of the connecting rod, and

(iv) angular acceleration of the connecting rod.

2. Answer *any one* of the following : **14**

(a) (i) Define the terms 'co-efficient of fluctuation of energy', and 'co-efficient of fluctuation of speed'. Also explain the function of a fly wheel in a prime mover.

(ii) The maximum and minimum speed of a fly wheel are 242 rpm and 238 rpm respectively. The mass of fly wheel is 2600 kg and radius of gyration is 1.8 m.

Find :

(A) mean speed of fly wheel

(B) maximum fluctuation of energy, and

(C) co-efficient of fluctuation of speed.

(b) The torque exerted on the crank-shaft of a two-stroke engine is given by the equation :

$$T = 3500 + 500 \sin 2\theta - 1000 \cos 2\theta$$

Where θ is the crank displacement from inner dead centre, and Torque(T) is in Nm. Assuming the resisting torque to be constant, determine :

(i) the power developed when the engine speed is 400 rpm.

(ii) the total fluctuations in speed (in percentage), and

(iii) the maximum retardation of the fly wheel.

The mass of the fly wheel is 250 kg, and its radius of gyration is 750 mm.

3. Answer *any one* of the following : **14**

(a) A 60° V engine has two cylinders which are placed symmetrically. The connecting rod of each the cylinder is connected to a single crank. The stroke is 120 mm and length of each connecting rod is 2 m. The mass of the reciprocating parts per cylinder is 1.25 kg. Determine the value of primary force when crank is rotating at a speed of 2000 rpm.

(b) A four-cylinder vertical engine has cranks 300 mm long. The planes of rotation of the first, third and fourth cranks are 750 mm, 1050 mm and 1650 mm respectively from that of the second crank and their reciprocating masses are 150 kg, 400 kg and 250 kg respectively. Find the mass of the reciprocating parts for the second cylinder and the relative position of the cranks in order that the engine may be in complete primary balance.

4. Answer ***any one*** of the following : **14**

(a) A car is of total mass 3000 kg. It has wheel base equal to 2.5 m and track width equal to 1.5 m. The effective diameter of each wheel is 80 cm, and moment of inertia of each wheel is 1.0 kg m^2. The rear axle ratio is 4. The mass moment of inertia of engine rotating parts is 3 kg m^2 and spin axis of engine parts is perpendicular to the spin axis of wheels. Determine the reaction at each wheel if car takes right turn of 100 m radius at 108 km/hr speed. Also determine critical speed. The height of C.G is 0.5 m from ground and it is placed on the vertical line through geometric centre of wheels.

(b) An aircraft consists of a propeller. It also consists of engine and propeller of mass moment of inertia 150 kg m^2. The engine rotates at 3600 rpm in a sense clockwise looking from rear. The aircraft completes half circle of radius 100 m towards left when flying at 360 km/hr. Determine the gyroscopic couple on the aircraft and state its effect.

5. Answer *any two* of the following : 7+7

(a) Explain in brief the Gyroscopic effect on critical speed of rotating shafts.

(b) A shaft is simply supported at the ends and is of 20 mm in diameter and 600 mm in length. The shaft carries a load of 9.81 N at its centre. The weight of shaft per metre length is 124.1 N. Find the critical speed of the shaft.

Take Young's modulus = 200 GN/m^2.

(c) A shaft is simply supported at its ends and is of 40 mm in diameter and 2.5 m in length. The shaft carries three point loads of masses 30 kg, 70 kg and 45 kg at 0.5 m, 1 m and 1.7 m respectively from the left support. The weight of the shaft per metre length is given as 73.575 N. The Young's modulus for the material of the shaft is 200 GN/m^2. Find the critical speed of the shaft.
