No. of Printed Pages : 5 **BIMEE-007**

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

00909

December, 2013

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. (a) State D - Alembert's principle. What is meant by a dynamically equivalent system ? **4**

Attempt **any one** of the following : **10**

(b) The lengths of the crank and connecting rod of a horizontal reciprocating engine are 200 mm and 1.0 m respectively. The crank is rotating at 400 rpm. When the crank has turned 30° from the inner deed centre, the difference of pressure between the cover end and piston end is 0.4 N/mm^2. If the mass of the reciprocating parts is 100 kg and cylinder bore is 0.4 m, then calculate :

(i) Inertia force.

(ii) Force on piston.

(iii) Piston effort.

(iv) Thrust on the sizes of cylinder walls. Neglect the effect of piston rod diameter and frictional resistance.

(c) The lengths of crank and connecting rod of a horizontal reciprocating engine are 200 mm and 1.0 respectively. The crank is rotating at 200 rpm. When the crank has turned 30° from the inner deed 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) Explain clearly how the functions of flywheel and governor differ from each other in a steam engine.

(ii) Find the maximum and minimum speeds of a flywheel of mass 5200 kg and radius of gyration 1.8 m when the fluctuation of energy is 100800 Nm. The mean speed of the engine is 180 r.p.m.

(b) The turning moment - diagram (T - M diagram) of an engine rotating at a mean speed of 300 rpm is given by the relation.

$T = 7500 + 4000 \sin 2\phi - 1000 \cos 2\phi$,

Where Torque T is in Nm, ϕ is the crank angle. External resistance is constant. A flywheel of mass 1000 kg is fitted on the engine shaft so that the total fluctuations of speed does not exceed by 1%.

Determine the least value of the moment of inertia and radius of gyration of the flywheel.

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

(a) A 90° – V engine has two cylinders which are placed symmetrically. The two connecting rods operate a common crank. The length of connecting rods are 400 mm each and crank radius is 100 mm. The reciprocating mass per cylinder is 4.8 kg. If the engine speed is 1200 rpm, then find the resultant primary and secondary forces. Also find the maximum resultant secondary force.

(b) A four - cylinder vertical engine has cranks 225 mm long. The planes of rotation of the first, second, and fourth cranks are 600 mm, 300 mm and 300 mm respectively from the third crank and their reciprocating masses are 100 kg, 120 kg, and 100 kg respectively. Find :

(i) the mass of the reciprocating parts for the third cylinder, and

(ii) the relative answer positions of the crank in order that the engine may be in complete primary balance.

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

(a) A trolley car weighing 3 tonnes run on rails 1 m apart at speed of 40 kmph. The track is curved with a radius of 80 m towards right side of the driver. The car has four wheels each of diameter 70 cm and mass moment of inertia 15 kg m^2. The car is driven by a motor of mass moment of inertia 10 kgm^2. The motor is placed centrally in the car and rotates nine times the speed of the axle in the same sense. The height of C.G of the car is 1 m above the rail level. Determine the height by which the outer rail should be lifted up as compared to the inner rail to overcome the effect of gyroscopic couple and couple due to centrifugal force.

(b) The mass of the motor cycle along with the rider is 180 kg. The height of the centre of gravity of total mass is 60 cm above the ground when it moves straight. Each wheel has diameter equal to 70 cm and polar mass moment of inertia of each wheel is 2 kgm^2. The engine rotates at a speed 5 times the road wheel and engine rotating parts have polar moment of inertia equal to 0.2 kgm^2. Determine the angle of heel required if motor cycle negotiates a curve of radius 100 m at a speed of 108 km/hr.

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

(a) Define Critical Speed of a shaft. Prove that the critical speed of shaft in r.p.s. (rotation per second) is given by the relation ;

$$N_c = \frac{0.4985}{\sqrt{\delta}}$$

Where δ = static deflection under the load W

(b) A shaft is simply supported at its ends and is of 40 mm in diameter and of length 5 m. The shaft carries three point loads of masses 15 kg, 35 kg, and 22.5 kg at 1 m, 2 m, and 3.4 m respectively from the left support. The weight of the shaft per metre length is given as 18.394 N. The Young's modulus for the material of the shaft is 200 GN/m^2. Find the critical speed of the shaft.

(c) 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 19.62 N at its centre. The weight of shaft per metre length is 248.2 N. Find the critical speed of the shaft.

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