Registration No:

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B.TECH 5th SEMESTER EXAMINATIONS, NOV/DEC 2019
BMEPC5040   DYNAMICS OF MACHINERY
Mechanical Engineering

Time : 3 Hours   Maximum : 100 Marks

Answer ALL Questions

The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions) 10 x 2=20 Mark

Q.1. Answer _All_ Questions

a   A rigid body, under the action of external forces, can be replaced by two masses placed at a fixed distance apart. The two masses form an equivalent dynamical system, if **[CO1] [PO2]**
(a) the sum of two masses is equal to the total mass of the body
(b) the centre of gravity of the two masses coincides with that of the body
(c) the sum of mass moment of inertia of the masses about their centre of gravity is equal to the mass moment of inertia of the body
(d) all of the above

b   The ratio of the maximum fluctuation of speed to the mean speed is called **[CO1] [PO2]**
(a) fluctuation of speed   (b) maximum fluctuation of speed
(c) coefficient of fluctuation of speed   (d) none of these

c   The ratio of the maximum fluctuation of energy to the, ... is called coefficient of fluctuation of energy. **[CO1] [PO3]**
(a) minimum fluctuation of energy   (b) work done per cycle
(c) maximum fluctuation of speed   (d) coefficient of fluctuation of speeds

d   A governor is said to be hunting, if the speed of the engine **[CO2] [PO2]**
(a) remains constant at the mean speed   (b) is above the mean speed
(c) is below the mean speed   (d) fluctuates continuously above and below the mean speed.

e   A motor car moving at a certain speed takes a left turn in a curved path. If the engine rotates in the same direction as that of wheels, then due to the centrifugal forces **[CO2] [PO2]**
(a) the reaction on the inner wheels increases and on the outer wheels decreases
(b) the reaction on the outer wheels increases and on the inner wheels decreases
(c) the reaction on the front wheels increases and on the rear wheels decreases (d) the reaction on the rear wheels increases and on the front wheels decreases

f   The frictional torque transmitted by a disc or plate clutch is same as that of **[CO3] [PO1]**
(a) flat pivot bearing   (b) flat collar bearing
(c) conical pivot bearing   (d) trapezoidal pivot bearing

g   The brake commonly used in motor cars is **[CO3] [PO1]**
(a) shoe brake   (b) band brake   (c) band and block brake   (d) internal

h   Longitudinal vibrations are said to occur when the particles of a body move **[CO4] [PO2]**
(a) perpendicular to its axis (b) parallel to its axis (c) in a circle about its axis (d) none

i   The frictional torque transmitted in a flat pivot bearing, considering uniform pressure, is **[CO4] [PO2]**
(a) $\frac{1}{2}\mu WR$ (b) $\frac{2}{3}\mu WR$ (c) $\frac{3}{4}\mu WR$ (d) μWR

j   In a locomotive, the maximum magnitude of the unbalanced force along the perpendicular to the line of stroke, is known as **[CO4] [PO2]**
(a) tractive force   (b) swaying couple (c) hammer blow (d) none of these

PART – B: (Short Answer Questions) 10X2=20 Marks
Q.2. Answer _ALL_ questions

a   Differentiate between static force analysis and dynamic force analysis.   [CO1] [PO2]
b   Why smaller flywheel is used in multi-cylinder engines?   [CO1] [PO2]
c   What is meant by isochronous condition in governors?   [CO2] [PO3]
d   Give the applications of gyroscopic couple.   [CO2] [PO3]

e   Define gyroscopic couple. [CO2] [PO1]
f   Define clutch [CO3] [PO2]
g   What do you mean by spin, precession and gyroscopic planes? [CO3] [PO3]
h   What is meant by degrees of freedom in a vibrating system? [CO4] [PO3]
i   Define logarithmic decrement. [CO4] [PO3]
j   Explain the term 'whirling speed' or 'critical speed' of a shaft. [CO4] [PO1]

PART – C: (Long Answer Questions) 4X15=60 Marks

Answer _ALL_ questions

Q.3

a   Find the inertia force for the following data of an I.C. engine [CO1] [PO2]
    Bore = 175 mm, stroke = 200 mm, engine speed = 500 r.p.m., length of connecting rod   5 Marks
    = 400 mm, crank angle = 60° from T.D.C. and mass of reciprocating parts = 180 kg
b   A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm   10 Marks   [CO1] [PO1]
    stroke and runs at 200 rpm. The reciprocating parts has a mass of 225 kg and the piston
    rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned
    through 125° from T.D.C., the steam pressure above the piston is 30 kN/m^2 and below
    the piston is 1.5 kN/m^2. Calculate the effective turning moment on the crank.

OR

c   The mass of flywheel of an engine is 6500 kg and the radius of gyration is 1.8 metres. [CO1] [PO1]
    It is found from the turning moment diagram that the fluctuation of energy is 56 kN-m.   5 Marks
    if the mean speed of the engine is 120 rpm, find the maximum and minimum speeds.
d   The T-θ diagram of a multi-cylinder Diesel engine consists of intercepted areas which   10Marks   [CO1] [PO3]
    are +52,-124,+92,-140,+85, -72 and +107 mm^2 in one cycle taken in order. The torque
    axis scale is 1 mm = 600 N-m and crank angle scale is 1 mm = 3˚. Mean speed of the
    engine is 600 rpm. If the total fluctuation of speed is to exceed ±1.5% the mean, find
    the necessary mass of the flywheel of radius 0.5 m

Q.4

a   An aeroplane makes a complete half circle of 50 metres radius, towards left, when [CO2] [PO3]
    flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of
    400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise   5 Marks
    when viewed from the rear. Find the gyroscopic couple on the aircraft and state its
    effect on it.
b   The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m [CO2] [PO3]
    and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the
    gyroscopic couple and its effect upon the ship:
    1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.   10 Marks
    2. when the ship is pitching in a simple harmonic motion, the bow falling with its
    maximum velocity. The period of pitching is 40 seconds and the total angular
    displacement between the two extreme positions of pitching is 12 degrees.

OR

c   Prove that the height of a Watt governor is given by the expression [CO2] [PO3]
    $h = \frac{g}{\omega^2} = \frac{895}{N^2}$ in metres
    5 Marks
    by taking moments of all the forces acting on the ball and neglecting the mass of arms,
    links and sleeve
d   A Proell governor has all the four arms of length 250 mm. The upper and lower ends of [CO2] [PO3]
    the arms are pivoted on the axis of rotation of the governor. The extension arms of the
    lower links are each 100 mm long and parallel to the axis when the radius of the ball   10 Marks
    path is 150 mm. The mass of each ball is 4.5 kg and the mass of the central load is 36
    kg. Determine the equilibrium speed of the governor.

Q.5

a	Determine the maximum, minimum and average pressure in a plate clutch when the axial force is 4 kN. The inside radius of the contact surface is 50 mm and outside radius is 100 mm. Assume uniform wear.	6 Marks	[CO3] [PO3]
b	A single plate clutch, effective both sides, is required to transmit 25 kW at 3000 rpm. Determine the outer and inner radii of frictional surface if the coefficient of friction is 0.225, the ratio of radii is 1.25 and the maximum pressure is not to exceed 0.1 N/mm2. Also determine the axial thrust to be provided by springs. Assume the theory of uniform wear.	9 Marks	[CO3] [PO3]

OR

c	A band and block brake, having 14 blocks each of which subtends an angle of 15° at the centre, is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find: 1. maximum braking torque, 2. angular retardation of the drum, and 3. time taken by the system to come to rest from the rated speed of 360 r.p.m. The coefficient of friction between blocks and drum may be taken as 0.25	15 Marks	[CO3] [PO3]

Q.6

a	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.	10 Marks	[CO4] [PO3]
b	Draw the primary direct and reverse crank positions of a V-60° two cylinder symmetrically placed engine. The two connecting rods are coupled directly to a single crank	5 Marks	[CO4] [PO3]

OR

c	A shaft 50 mm in diameter and 1 m long is fixed horizontally at one end. It carries a transverse load of 1 kN at its free end. Find its frequency of transverse vibration. Take $E = 3 \times 10^5$ N/mm^2.	5 Marks	[CO4] [PO3]
d	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.	10 Marks	[CO4] [PO3]