B.E. PRODUCTION ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION-2024

MACHINE DYNAMICS

Time: Three Hours **Full Marks: 100**

Answer **ALL** questions.
All parts of a question (*a, b, c* etc) should be answered at one place.
Assume any missing data with proper justification.

1.a) What is the effect of gyroscopic couple on an aeroplane if it takes right turn instead of left turn? Explain with neat sketch.

OR

What is dynamical equivalent system? Why it is required?

b) The crank and connecting rod of a reciprocating engine, running at **1800 rpm** are **50 mm** and **200 mm** respectively. The diameter of the piston is **80 mm** and the mass of the reciprocating parts is **1 kg**. At a point during the power stroke the pressure on the piston is **0.7 N/mm²**, when it has moved **10 mm** from the **inner dead centre (I.D.C.)**. Determine (i) Net load on the gudgeon pin, (ii) Thrust on the connecting rod, (iii) Reaction force between the piston and cylinder.

OR

A ship has a rotor of mass **3 tonnes** rotating at **2500 rpm** and its radius of gyration is **30 cm**. If the rotation of the rotor is clockwise looking from the stern calculate the gyroscope couple that is set on the ship by rotor when

(i) the ship takes a left hand turn with a radius of **400m** at a speed of **50 km/h**,
(ii) pitching of the bow at an angular velocity of **2 rad/s** and
(iii) ship rolls due to the wave with a velocity of **0.1 rad/s**.

5+15=20

2.a) How does the function of a governor differ from that of a flywheel? – Explain.

b) What do you mean by Effort and Power of a governor?

OR

What do you mean by coefficient of fluctuation of energy and coefficient of fluctuation of speed of a flywheel?

c) A Proell governor has equal arms of length **300 mm**. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each **80 mm** long and parallel to the axis when the radii of rotation of the balls are **150 mm** and **200 mm**. The mass of each ball is **10 kg** and the mass of the central load is **100 kg**. Calculate the

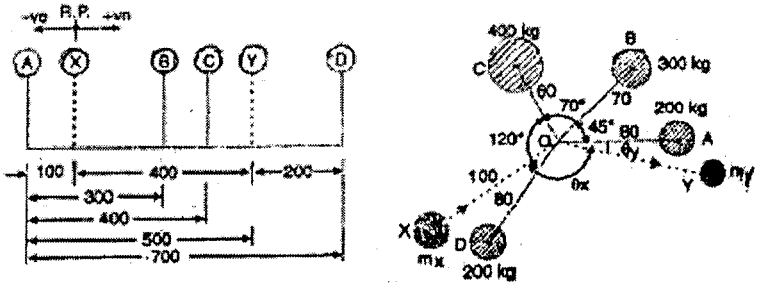
range of speed of the governor.

OR

A certain machine requires a torque of **(5000 + 500Sinθ) N-m** to drive it, where θ is the angle of rotation of shaft measured from certain datum. The machine is directly coupled to an engine, which produces a torque of **(5000+ 600Sin2θ) N-m**. The flywheel and the other rotating parts attached to the engine have a mass of **500** kg at a radius of gyration **0.4m.** If the mean speed is **150 rpm**, calculate the fluctuation of the speed of the flywheel in percentage.

4+6+10 = 20

3. A shaft carries four masses **A, B, C and D (Fig. 1)** 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.



All dimensions in mm.

(a) Position of planes. (b) Angular position of masses.

Fig. 1

OR

A four crank engine has two outer cranks set at **120°** to each other and their reciprocating masses are each **400 kg**. The distance between the planes of rotation of adjacent cranks are **450 mm**, **750 mm** and **600 mm**. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks.
If the length of each crank is **300 mm**, the length of each connecting rod is **1.2 m** and the speed of rotation is **240 rpm**, find the maximum secondary unbalance force?

20

4.a) A thin rectangular plate having mass **'M'** is bent into semi-circular cylinder of radius **'R'** as shown in **Fig.2**. Determine its period of oscillation if it is allowed to rock on a horizontal surface without slip.

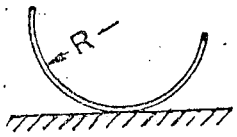


Fig. 2

OR

A mass is suspended by an intermediate string with the help of pulleys and springs as shown in **Fig. 3**. Find the natural frequency of the system.

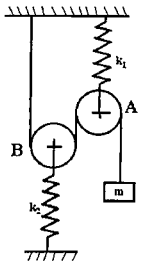


Fig. 3.

b) Determine the **natural frequency** of the following vibrating systems when (i) mass is suspended at the bottom of **two springs in series** and (ii) mass is fixed **in between two masses**. Take stiffness of two springs as **5 N/m** and **8 N/m** and the mass suspended as **10 kg**.

OR

When a machine part having a mass of **2.5** kg vibrates in a viscous medium. Harmonic exciting force of **30** N acts on the part and causes resonant amplitude of 14 mm with a period of **0.22** sec. Find the **damping coefficient**. If the frequency of the exciting force is changed to **4** Hz determine the **increase in the amplitude** of the forced vibrations upon the removal of the damper.

10+10=20

5.. Analyse the slider crank mechanism of a reciprocating engine for forces neglecting the effect of weight and the inertia of the connecting rod.

OR

Analyse the following problem shown in **Fig. 4** for steady state response.

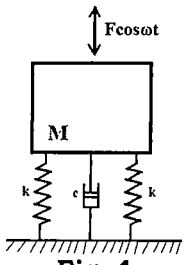


Fig. 4

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