B.E. PRODUCTION ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION-2022

MACHINE DYNAMICS

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

Answer **any FIVE** 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) Explain with neat sketch the motions: pitching, rolling and steering for a ship.

b) Why the gyroscopic couple does not act on the naval ship body in case of rolling?-Explain.

c) An aeroplane consisting of a rotary engine and propeller of the plane has a mass of **400 kg** with radius of gyration of **300 mm**. The engine completes a half circle of **50 metres** radius, towards left, when flying at **200 km** per hour. The engine runs at **2400 r.p.m clockwise**, when viewed from the rear. Estimate the gyroscopic couple on the aircraft and state its effect on it. Also, what will be the effect, if the aeroplane turns to its right instead of the left?

6+4+10=20

2.a) Classify the governors according to their principles of functioning.

b) Discuss the working principle of a centrifugal governor with neat sketch.

c) In a Porter governor, each of the four arms is **400 mm** long. The upper arms are pivoted on the axis of the sleeve whereas the lower arms are attached to the sleeve at a distance of **45 mm** from the axis of rotation. Each ball has a mass of **8 kg** and the load on the sleeve is **60 kg**. What will be the equilibrium speeds for the two extreme radii of **250 mm** and **300 mm** of the governor balls? Neglect the friction.

4+6+10 = 20

3. The equation of the turning moment curve of a three crank engine is **(5000+1500sin 3θ) N-m**, where θ is the crank angle in radians. The moment of inertia of the flywheel is **1000 kg-m^2** and the mean speed is **300 rpm**. Estimate (1) power of the engine and (2) the maximum fluctuation of the speed of the flywheel when (i) the resisting torque is constant and (ii) the resisting torque is **(5000+600sin 3θ) N-m**.

20

4. 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.

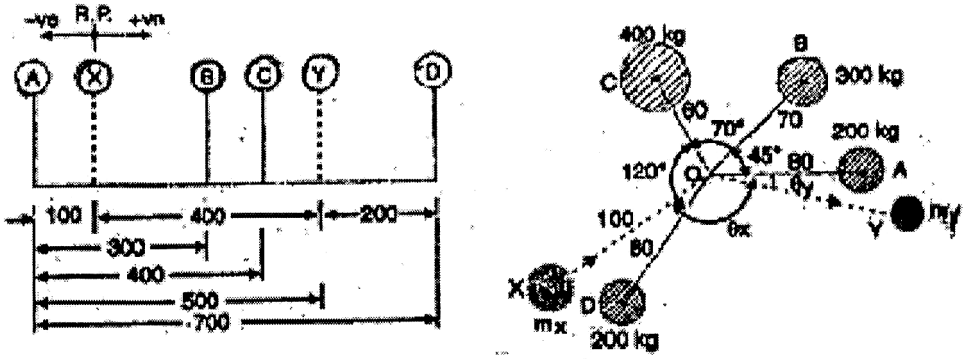

Fig. 1

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5. The successive cranks of a five-cylinder in-line engine are at **144°** apart. The spacing between cylinder centre lines is **400 mm**. The lengths of the crank and the connecting rod are **100 mm** and **450 mm** respectively and the reciprocating mass for each cylinder is **20 kg.** The engine speed is **630 rpm.** Find the maximum values of the primary and secondary forces and couples and the position of the central crank at which these occur.

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6.a) A mass is suspended by an intermediate string with the help of pulleys and springs as shown in **Fig. 2**. Find the natural frequency of the system.

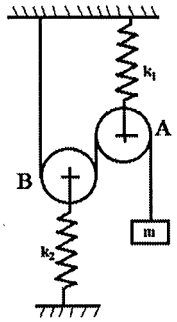

Fig. 2.

b) A **vibrating system** consisting of a weight of **25 N** and a spring of stiffness **2 kN/m** is viscously damped such that the ratio of any two consecutive amplitudes is **0.98**. Determine:

i) the **natural frequency** of the damped system,
ii) the **logarithmic decrement,**
iii) the **damping co-efficient.**

10+10=20

7.a) What do you mean by static balancing and dynamic balancing of rotating masses?

b) State and prove the 'Kennedy's Theorem' of three instantaneous centres.

c) Free damped vibration record of a **1000 kg** machine mounted on an isolator containing a spring and a dashpot, shows that in **4 cycles** the amplitude of oscillation

diminishes from **5 mm** to **0.1 mm**. The time period between two successive peaks is **0.64 sec**. Determine the **stiffness** of the spring and the **damping constant** of the dashpot.

5+5+10=20

8.a) Discuss the conditions for a dynamically equivalent system in order to determine the motion of a rigid link.

b) With a neat sketch explain the **thrust** on the sides of the cylinder walls of a horizontal reciprocating engine.

c) In the **toggle mechanism** as shown in **Fig. 3**, the crank **OA** rotates at **210 rpm counter-clockwise** increasing at the rate of **60 rad/s^2**. For the given configuration, **determine** the **angular acceleration** of **link BD**.

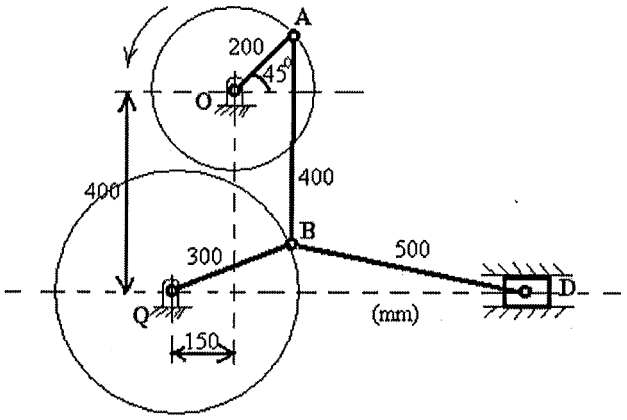

Fig. 3

5+5+10=20

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

b) What is the instantaneous centre of rotation (centro) in kinematic of machines? Why it is important?

c) In a quick-return mechanism as shown in the **Fig. 4**, the crank rotates in anti-clockwise direction at **120 rpm**. The lengths of crank AB and the slotted arm OC are **150mm** and **700mm** respectively. The link CD is **200 mm** long. Determine the velocity and acceleration of the ram D and also the angular acceleration of the slotted lever.

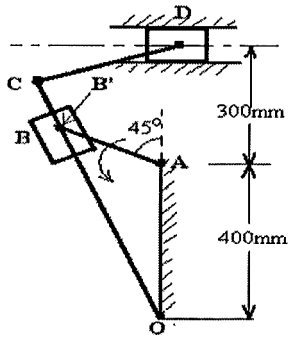

Fig. 4

5+(3+2)+10=20

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