Ex/Prod/T/225/2018

B. E. PRODUCTION ENGG. 2ND YEAR 2ND SEMESTER EXAMINATION, 2018

MACHINE DYNAMICS

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

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

1.a) The gyroscopic couple does not act on the ship body in case of rolling. Explain with neat sketch.

b) For the turbine rotor of a ship, mass of **20 tonne**, radius of gyration of **75cm** and speed of **200 rpm** (clockwise when viewed from the Bow of the ship). The ship pitches harmonically with amplitude of **10°** and a time period of **20sec**. The turbine is supported on bearings **5m** apart. Estimate the maximum reaction at the front bearing and the direction of this reaction force when the front of the ship is rising. The *c.g.* (centre of gravity) of the rotor may be assumed to be at the midspan between the bearings.

OR

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?

5+15=20

2. a) How does a governor differ from that of a flywheel? - Explain.

b) The arms of a Porter governor are **300 mm** long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to a sleeve at a distance of **40 mm** from the axis of rotation. The sleeve and each ball of governor are **70 kg** and respectively. Determine the equilibrium speed when the radius of rotation of the **10 kg** balls is **200 mm**. If the friction is equivalent to a load of **20 N** at the sleeve, what will be the range of speed for this position?

5+15=20

OR

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**.

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3. A shaft supported in bearings that are **1.6 m** apart projects **400 mm** beyond bearings at each end. It carries three pulleys one at each end and one at the centre of its length. The masses of the end pulleys are **40 kg** and **22 kg** and their centres of mass are at **12 mm** and **18 mm** respectively from the shaft axes. The mass of the centre pulley is **38 kg** and its centre of mass is **15 mm** from the shaft axis. The pulleys are arranged in a manner that they give static balance. Find the (i) relative angular positions of the pulleys and (ii) dynamic forces developed on the bearings when the shaft rotates at **210 rpm.**

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OR

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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4.a) A circular cylinder of mass **4 kg** and radius **150 mm** is connected by a spring of stiffness **4 KN / m** as shown in **Fig. 1**. It is free to roll on horizontal rough surface without slipping. Determine the natural frequency.

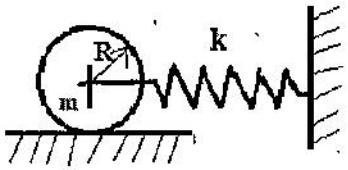

Fig. 1

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OR

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.

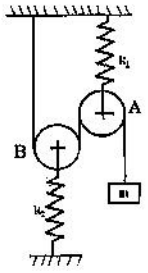

Fig. 2.

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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 amplitude is **0.98.** Determine:

(i) the **natural frequency** of the **damped system.**
(ii) the **logarithmic decrement,**

[TURN OVER]

(iii)**damping co-efficient**

OR

A vibratory system in a vehicle is to be designed with the following parameters: **K= 100 N/ m, C= 2 N-sec/ m , m= 1 kg**. Calculate (i) the decrease in amplitude from its starting value after **3 complete oscillations** and (ii) the frequency of oscillation.

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

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OR

Analyse the following problem shown in Fig. 3 for steady state response.

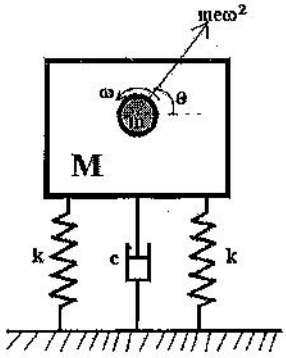

Fig. 3

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