Ex/Prod/T/225/2017

B. E. PRODUCTION ENGG. 2ND YEAR 2ND SEMESTER EXAMINATION, 2017

MACHINE DYNAMICS

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

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

Answer any **FIVE** questions.

1.a) With a neat sketch of a ship, show and explain the different axes associated with the movement of a ship.

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

c) 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+5+10) = 20

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

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

c) A Proell governor has each arm **28.3**cm long. The pivots of the upper and lower arms are **2**cm from the axis. The central load acting on the sleeve has a mass of **30** kg and the each rotating ball has a mass of **3.5** kg. When the governor sleeve is in mid-position, the extension link of the lower arm is vertical and the radius of the path of rotation of the masses is **22**cm. The vertical height of the governor is **20**cm and the governor speed is **170** rpm. Find (i) **length** of the extension link, (ii) **tension** in the upper arm and also sketch the system.

(6+4+10) = 20

3. The crank and connecting rod of a reciprocating engine, running at **1800** r.p.m. 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/mm^2, 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 and (iv) **the speed** at which the above values become zero.

20

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

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

c) In the **toggle mechanism** as shown in **Fig. 1**, 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**.

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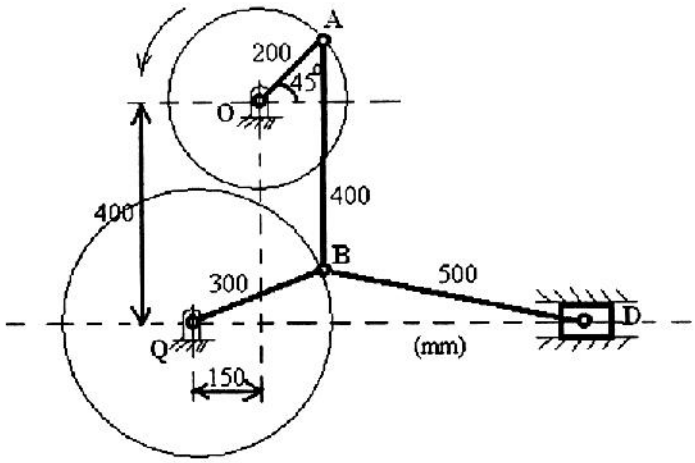

Fig. 1.

(5+5+10) = 20

5. A shaft carries three masses **B, C** and **D** of magnitude **30 Kg, 50 Kg** and **40 Kg** respectively and revolving at radii **240 mm, 120 mm** and **150 mm** in different respective planes. The planes containing masses **B** and **C** are **300 mm** apart. The angles between the cranks measured anticlockwise are **B to C 90°** and **B to D 220°**. Balancing mass is to be placed in plane **A**. If the balancing mass revolves at radius **180 mm**, find,
   (i) The magnitude and angular position of mass **A and**
   (ii) The position of planes **A** and **D**.

20

6.a) 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 **(a)** the decrease in amplitude from its starting value after **3 complete** oscillations and **(b)** the frequency of oscillation.

b) A machine weighing a mass of **100 Kg** and supported on springs of total stiffness **7.84×10^5 N/ m** has an unbalanced rotating element which results in a disturbing force of **392 N** at a speed of **3000 rpm**. Assuming a damping factor of **$\zeta = 0.2$,** determine, **(a)** the amplitude of motion due to unbalance **(b)** the transmissibility **(c)** the transmitted force to the supporting structure.

(10+10) = 20

7.a) Determine the **natural frequency** of the following vibrating systems as shown in Fig. 2 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 s_1= **5 N/m** and s_2 = **8 N/m** and the mass suspended as m = **10 kg**.

Fig. 2.

b) 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

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

b) What do you mean by static balancing and dynamic balancing of rotating masses?

c) Determine all possible **centros** of the mechanism shown in the following **Fig. 3**. Determine **(i)** the angular velocities of links **4** and **5**and **(ii)** velocity of points $\mathbf{P_1}$, $\mathbf{P_2}$ and $\mathbf{P_3}$. Also, determine the acceleration of '**C**'.

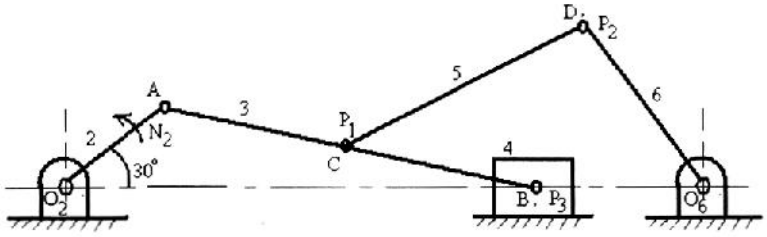

Fig. 3.

O_2A = 4cm, AB=10cm, O_2O_6=24cm, AC= CB, CD=8cm, O_6D=8cm, N_2=4000rpm.

(5+3+12) = 20

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