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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

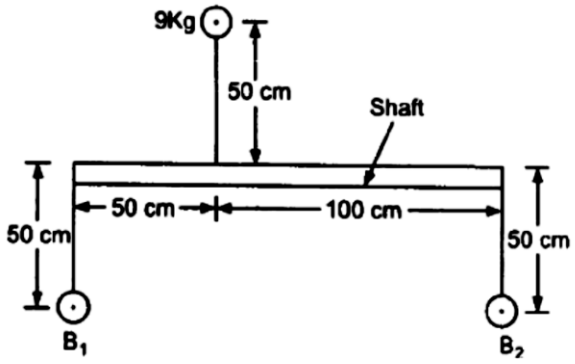
Program/course: Mechanical Engineering	**Semester – V**
Subject: Dynamics of Machines	**Max. Marks : 100**
Code : MHEG 366	**Duration : 3 Hrs**
No. of page/s: 5	

Uses of drawing tools are allowed during the examination. Assume any data if not provided. Read / understand the problem before solving.

Section A -Attempt all the questions (24 Marks)

1. Attempt all the questions in continuous manner.
   (a) Draw and discuss the transmissibility versus ratio of frequency curve. 4
   (b) Explain whirling of shaft. Derive an expression for amplitude of vibration of shaft supporting a disc at mid span and discuss the significance. 5
   (c) For a certain engine having an average speed of 1200 rpm, a flywheel approximated as a solid disc, is required for keeping the fluctuation of speed within 2% about the average speed. The fluctuation of kinetic energy per cycle is found to be 2 kJ. What is the least possible mass of the flywheel if its diameter is not to exceed 1m? 5

   (d) Masses B_1, B_2 and 9 kg are attached to a shaft in parallel planes as shown in the figure. If the shaft is rotating at 100 rpm, determine the mass B_2. **5**



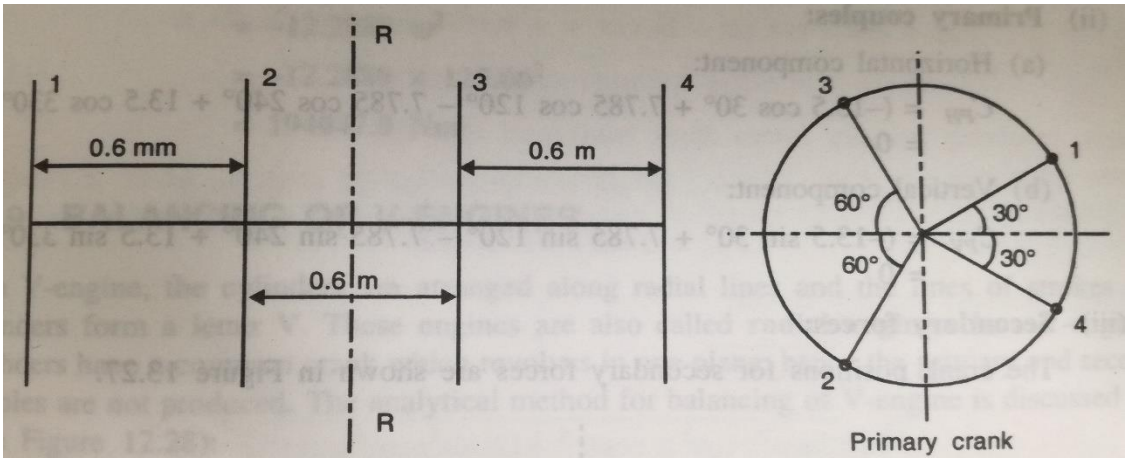
   (e) In a Hartnell governor, the mass of each ball is 2.5 kg. Maximum and minimum speeds of rotation are 10 rad/s and 8 rad/s respectively. Maximum and minimum radii of rotation are 20 cm and 14 cm respectively. The lengths of horizontal and vertical arms of bell crank levers are 10 cm and 20 cm respectively. Neglecting obliquity and gravitational effects, determine lift of the sleeve. 5

SECTION B (3x 12 =36)

Attempt 3 questions. However there is internal choice in Q.No. 2.

Q.No. 2 (12 Marks)

Four cylinder in line IC Engine, the mass of reciprocating parts of cylinder 1 and 4 are 100 kg and that of cylinder number 2 2 and 3 are 173 kg. If the crank radius is 150 mm, length of connecting rod is 450 mm and engine speed is 1200 rpm, determine the primary and secondary forces and couples. Cylinders are placed 600 mm apart as shown in figure. R-R may be taken as reference plane. 12



OR

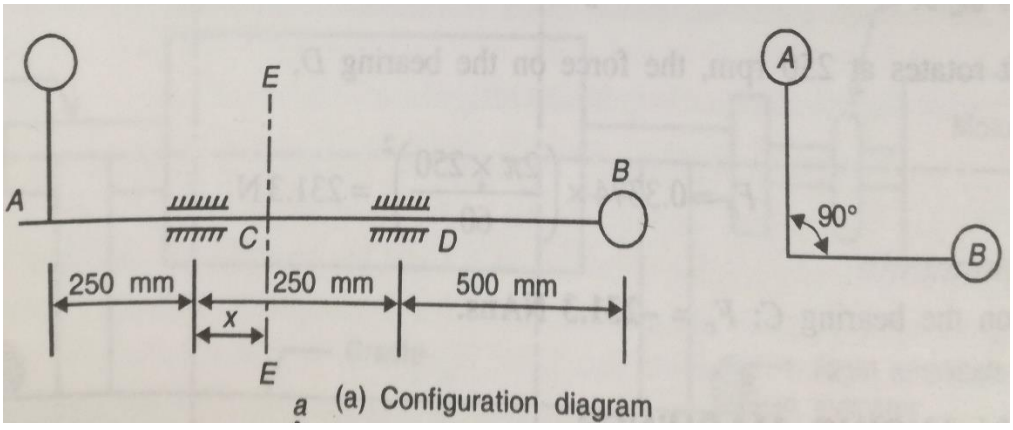
Q.No. 2 (12 Marks)

A shaft rotating at uniform speed carries two discs A and B mass of 5 kg and 4 kg respectively. The centre of gravity of each disc is 2.7 mm away from the the axis of rotation and angle between them is 90^0. The shaft bearings C and D, between A and B , such that AC= 250 mm , AD= 500 mm and AB = 1000 mm. It is desired to make the dynamic forces on bearings equal and opposite and to have minimum value for a given speed by means of a mass E at a radius of 20 mm .

Determine

(i) Magnitude of mass to be attached at E and its angular position with respect to that of A.

(ii) The distance of plane E from plane A. 12



3. The variation of crank-shaft torque of four cylinder petrol engine may be approximately represented by taking torque as zero at crank angle 0^0 and 180^0 and as 255 N.m for crank angles 20^0 and 45^0, the intermediate portions of the torque graph being straight lines. The cycle is repeated in every half revolution. The average speed is 600 rpm . Supposing that the engine drives a machine requiring constant torque, determine the weight of the weight of flywheel of radius of gyration 25 cm which must be provided so that the total variation in speed shall be one percent. Solve after drawing the T-θ diagram. 12

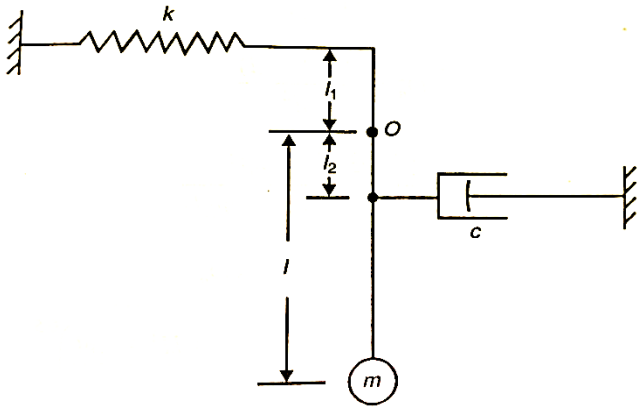
4. In spring loaded governor of Hartnell type, the weight of each ball is 59 N and the lift of sleeve is 5 cm. The speed at which the governor begins to float (lowest speed) is 240 rpm and at this speed the radius of ball path is 11 cm. The mean working speed of governor is 20 times the range of the speed when friction is neglected. If the length of ball and roller arms of bell crank lever are 12 cm and 10 cm respectively and if the distance between centre of pivot of the bell crank lever and axis of governor spindle is 14 cm, determine the initial compression of the spring , taking into account the obliquity of arms. If the friction is equivalent to a force 29.4 N at sleeve , find the total alteration in the speed before the sleeve begins to move from mid-position. 12

SECTION C (2x 20 = 40)

Attempt 2 questions. However there is internal choice in Q.No. 5.

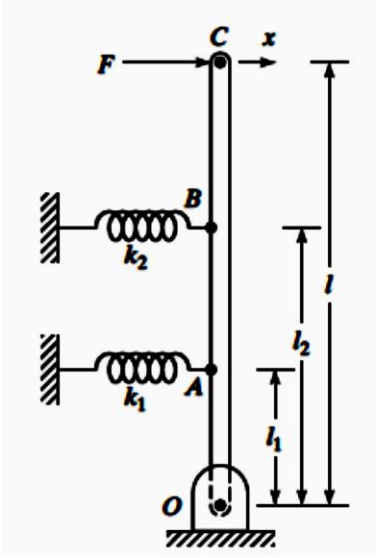
Q.No. 5 (20 Marks)

(a)A single pendulum is pivoted at point O as shown in figure . If the mass of rod is negligible for small oscillations, find the damped natural frequency of pendulum. 10



Where m, c and k are the mass, damping coefficient and spring stiffness respectively.

5. (b) A hinged rigid bar of length l is connected by two springs of stiffness k_1 and k_2 and is subjected to a force F as shown in Fig. Assuming that the angular displacement of the bar is small, find the equivalent spring constant of the system that relates the applied force F to the resulting displacement x. **10**

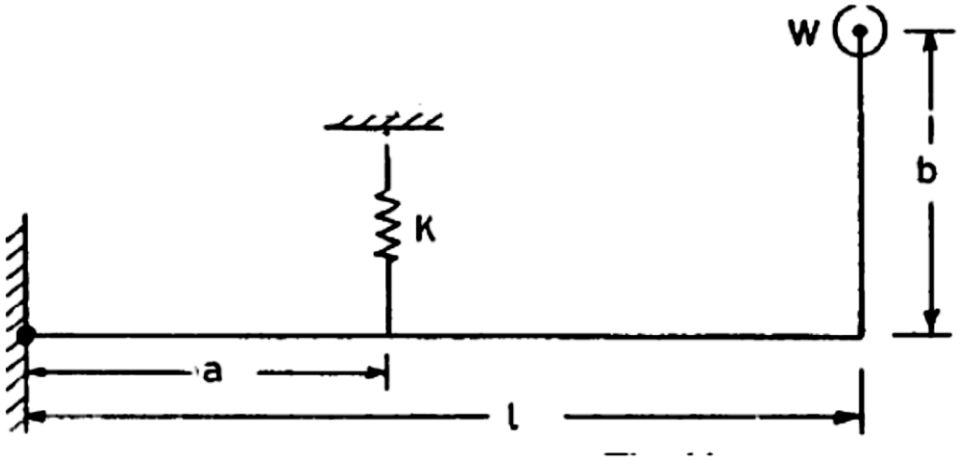


OR

Q.No. 5 (20)

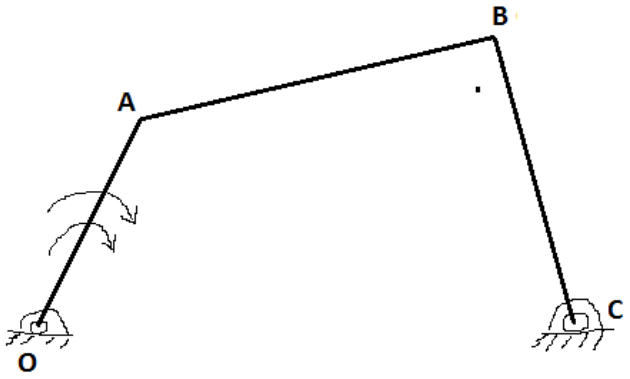
(a) A machine having 300 kg mass is mounted on isolators. The combined stiffness and damping coefficient of isolators are 5 MN/m and 3,125 kNs/m. The machine is driven through a belt by electric motor of speed 3000 rpm,. Determine the vibratory amplitude of the machine at running speed due to harmonic force of excitation of 1 kN. Also determine the vibratory amplitude when machine speed passes through resonance condition. 10

(b) For the system shown in the given figure the moment of inertia of the weight W and the ball about the pivot point is Io, Determine the natural frequency of the system.



Also find the condition when system vibrates.

6. It is required to carry out dynamic force analysis of the four bar mechanism as shown in figure. The angular velocity and angular acceleration of link 2 are given as ;
ω_2 = 20 rad/s, α_2 = 160 rad/ s^2. The necessary linear dimensions are;
OA =25 cm, OG_2 = 11 cm, AB= 30 cm, AG_3 =15 cm , CG_4 = 14 cm, OC = 55 cm, and $\angle$ AOC =60^0.



The masses and moment of inertia of various members are $\frac{1}{m}$

Link	mass	Moment of inertia I_G kg-m^2
2	20.7 kg	0.01872
3	9.66 kg	0.01105
4	23.47 kg	0.0277
