Reg. No. \_\_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

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| **Code :** | **14ME2027** | **Duration :** | **3hrs** |
| **Sub. Name :** | **DYNAMICS OF MACHINERY** | **Max. Marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | Assess all the constraint forces and the torque T required for the linkage shown below, if the force F = 120 N. The dimensions of the links are as follows. AB = 60 mm, BC = 180 mm, CD = 120 mm, AD = 80 mm and DE = 50 mm. | CO1 | 14 |
| b. | State the equilibrium conditions of the following.  (i) member with two forces  (ii) member with three forces  (iii) member with two forces and a torque. | CO1 | 6 |
| **(OR)** | | | | |
| 2. | a. | The crank and connecting rod of a steam engine are 0.3 m and 1.5 m in length. The crank rotates at 180 r.p.m. clockwise. Examine the velocity and acceleration of the piston when the crank is at 40° from the inner dead center position. Also determine the position of the crank for zero acceleration of the piston. | CO1 | 10 |
| b. | When the crank has turned through 45° from top dead center, the effective steam pressure on the piston of a vertical steam engine is  3 bar. The diameter of the cylinder is 600 mm and stroke of the piston is 500 mm. The length of the connecting rod is 1 m. Estimate the torque on the crank shaft of the engine that runs at 420 r.p.m. and the mass of the reciprocating parts is 250 kg. | CO1 | 10 |
| 3. | a. | Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B, C and D are 60°, 135° and 270° from the mass A. Determine the magnitude and position of the balancing mass at a radius of 100 mm. | CO2 | 10 |
|  | b. | A shaft carries five masses A, B, C, D and E which revolve at the same radius in planes which are equidistant from one another. The magnitude of the masses in planes A, C and D are 50 kg, 40 kg and 80 kg respectively. The angle between A and C is 90° and that between C and D is 135°. Determine the magnitude of the masses in planes B and E and their positions to put the shaft in complete rotating balance. | CO2 | 10 |
| **(OR)** | | | | |
| 4. | a. | Four masses A, B, C and D revolve at equal radii and are equally spaced along a shaft. The mass B is 7 kg and the radii of C and D make angles of 90° and 240° respectively with the radius of B. Evaluate the magnitude of the masses A, C and D and the angular position of A so that the system may be completely balanced. | CO2 | 10 |
| b. | A, B, C and D are four masses carried by a rotating shaft at radii 100 mm, 150 mm, 150 mm and 200 mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and the magnitude of the masses B, C and D are 9 kg, 5 kg and 4 kg respectively. Evaluate the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. | CO2 | 10 |
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| 5. | a. | A shaft of 100 mm diameter and 1 metre long is fixed at one end and other end carries a flywheel of mass 1 tonne. Taking Young’s modulus for the shaft material as 200 GN/m2 , evaluate the natural frequency of longitudinal and transverse vibrations. | CO3 | 7 |
| b. | A shaft 1.5 m long is supported in flexible bearings at the ends and carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 0.4 m from the centre towards right. The shaft is hollow of external diameter 75 mm and inner diameter 37.5 mm. The density of the shaft material is 8000 kg/m 3 . The Young’s modulus for the shaft material is 200 GN/m2 . Evaluate the frequency of transverse vibration. | CO3 | 13 |
| **(OR)** | | | | |
| 6. | a. | A beam of length 10 m carries two loads of mass 200 kg at distances of 3 m from each end together with a central load of mass 1000 kg. Calculate the frequency of transverse vibrations. Neglect the mass of the beam and take I = 109 mm4 and E = 205×103 N/mm2 . | CO3 | 8 |
| b. | A shaft of diameter 10 mm carries at its centre a mass of 12 kg. It is supported by two short bearings, the centre distance of which is 400 mm. Assess the whirling speed by 1) neglecting the mass of the shaft, and 2) taking the mass of the shaft also into consideration. The density of shaft material is 7500 kg/m3 . | CO3 | 12 |
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| 7. | a. | A shaft of 100 mm diameter and 1 metre long is fixed at one end and the other end carries a flywheel of mass 1 tonne. The radius of gyration of the flywheel is 0.5 m. Estimate the frequency of torsional vibrations, if the modulus of rigidity for the shaft material is 80 GN/m2 . | CO4 | 6 |
|  | b. | The two rotors A and B are attached to the end of a shaft 500 mm long. The mass of the rotor A is 300 kg and its radius of gyration is 300 mm. The corresponding values of the rotor B are 500 kg and 450 mm respectively. The shaft is 70 mm in diameter for the first 250 mm,  120 mm for the next 70 mm and 100 mm diameter for the remaining length. The modulus of rigidity for the shaft material is 80 GN/m2 .  Assess the position of the node and frequency of torsional vibration. | CO4 | 14 |
| **(OR)** | | | | |
| 8. | a. | The flywheel of an engine driving a dynamo has a mass of 180 kg and a radius of gyration of 30 mm. The shaft at the flywheel end has an effective length of 250 mm and is 50 mm diameter. The armature mass is 120 kg and its radius of gyration is 22.5 mm. The dynamo shaft is  43 mm diameter and 200 mm effective length. Examine the position of node and frequency of torsional oscillation. The modulus of rigidity for the material is 83 kN/mm2 . | CO4 | 6 |
| b. | Three rotors A, B and C having moment of inertia of 2000 , 6000 , and 3500 kgm2 respectively are carried on a uniform shaft of 0.35 m diameter. The length of the shaft between the rotors A and B is 6 m and between B and C is 32 m. Evaluate the frequency of the torsional vibrations. The modulus of rigidity for the material is 80 GN/m 2 . | CO4 | 14 |
|  | | **Compulsory**: |  |  |
| 9. | a. | The length of the upper arm of a Watt governor is 400 mm and its inclination to the vertical is 30°. Estimate the percentage increase in speed, if the balls rise by 20 mm. | CO5 | 7 |
| b. | In a Porter governor, the mass of the central load is 18 kg and the mass of each ball is 2 kg. The top arms are 250 mm while the bottom arms are each 300 mm long. The friction of the sleeve is 14 N. If the top arms make 45° with the axis of rotation in the equilibrium position, evaluate the range of speed of the governor in that position. | CO5 | 13 |