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

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**End Semester Examination – Nov/Dec – 2018**

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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. | Find 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. | Briefly explain the equilibrium of the (i) member with two forces  (ii) member with three forces and (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 inlength. The crank rotates at 180 r.p.m. clockwise. Determine the velocity and acceleration of the piston when the crank is at 40° from the inner dead centre position. Also determine the position of the crank for zero acceleration of the piston. | CO1 | 10 |
| b. | The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm2. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected, calculate, (i) Pressure on slide bars,  (ii) Thrust in the connecting rod, (iii) Tangential force on the crank-pin, and (iv) Turning moment on the crank shaft. | CO1 | 10 |
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| 3. |  | A steam engine runs at 150 r.p.m. Its turning moment diagram gave the following area measurements in mm2 taken in order above and below the mean torque line:500,–250, 270, –390, 190, –340, 270, –250. The scale for the turning moment is 1mm = 500 N-m, and for crank angle is 1 mm = 5°.The fluctuation of speed is not to exceed ± 1.5% of the mean, determine the cross-section of the rim of the flywheel assumed rectangular with axial dimension equal to 1.5 times the radial dimension. The hoop stress is limited to 3 MPa and the density of the material of the flywheel is 7500 kg/m3. | CO2 | 20 |
| (OR) | | | | |
| 4. |  | A rotating shaft carries 4 unbalanced masses 18 kg, 14 kg, 16 kg and 12 kg at radii 50 mm, 60mm, 70 mm and 60 mm respectively. The 2nd, 3rd and 4th masses revolve in planes 80mm, 160mm and 280 mm respectively measured from the plane of the first mass and are angularly located at 60°, 135° and 270° respectively measured clockwise from the first mass looking from this mass end of the shaft. The shaft is dynamically balanced by two masses, both located at 50 mm radii and revolving in planes mid-way between the 1st and 2nd masses and midway between the 3rd and 4thmasses. Determine, the magnitudes of the balancing masses and the irrespective angular positions. | CO3 | 20 |
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| 5. | a. | A vibrating system consists of a mass of 8 kg, spring of stiffness 5.6 N/mm and dashpot of damping coefficient of 40 N/m/s. Find (i) critical damping coefficient, (ii) damping factor, (iii) natural frequency of damped vibration, and (iv) ratio of two consecutive amplitues. | CO4 | 10 |
| b. | A shaft 1.5 m long, supported in flexible bearings at the ends 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 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m3 and its modulus of elasticity is 200 GN/m2. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. | CO4 | 10 |
| (OR) | | | | |
| 6. |  | A machine has a mass of 100 kg and unbalanced reciprocating parts of mass 2 kg which move through a vertical stroke of 80 mm with simple harmonic motion. Themachine is mounted on four springs, symmetrically arranged with respect to centre of mass, in such a way that the machine has one degree of freedom and can undergo vertical displacements only.Neglecting damping, calculate the combined stiffness of the spring in order that the force transmitted to the foundation is 1/25th of the applied force, when the speed of rotation of machine crank shaft is 1000 r.p.m. When the machine is actually supported on the springs, it is found that the damping reduces the amplitude of successive free vibrations by 25%.  Find : i. the force transmitted to foundation at 1000 r.p.m., ii. the force transmitted to the foundation at resonance, and iii. the amplitude of theforced vibration of the machine at resonance. | CO4 | 20 |
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| 7. |  | 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 diameter 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. Find i. Position of the node; and ii. The frequency of the torsional vibration. | CO4 | 20 |
| (OR) | | | | |
| 8. |  | A 4-cylinder engine and flywheel coupled to a propeller are approximated to a 3-rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg-m2, the flywheel to a second rotor of 320 kg-m2and the propeller to a third rotor of 20 kg-m2. The first and second rotors being connected by 50 mm diameter and 2m long shaft and the second and the third rotors being connected by a 25 mm diameter and 2 m long shaft. Neglecting the inertia of the shaft and taking its modulus of rigidity as 80 GN/m2, determine natural frequencies of torsional oscillations and the positions of the nodes. | CO4 | 20 |
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|  | | **Compulsory:** |  |  |
| 9. | a. | The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalentof 20 N of load at the sleeve, determine how the speed range is modified. | CO5 | 10 |
| b. | The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic-couple and its effect upon the ship:(i) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. (ii) when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. | CO5 | 10 |