15. a) A Hartnell type governor with vertical axis has two rotating weights of 10 N each carried on bell crank levers in which, the two arms are of equal length. The mean radius of rotation of the governor balls is 100 mm and the sleeve has a total lift of 20 mm due to maladjustment of the spring, equilibrium speed of lowest sleeve position is 400 rpm and the highest position of the sleeve, 380 rpm. Determine the initial compression of the spring and spring stiffness. Also calculate the initial spring compression required if equilibrium speed at the lowest sleeve position is to be 250 rpm.

(OR)

b) The weight of a motor cycle has a total mass moment of inertia of 2.7 kg–m^2 and the rotating parts of the engine have mass moment of inertia of 0.12 kg–m^2. The gear ratio is 4:1 and the axis of rotation of the engine crank shaft is parallel to the axle of the rear wheel. The rear wheel has a diameter of 650 mm. Determine the magnitude of the gyroscopic couple when motor cycle rounds a curve of 30 m radius at a speed of 60 km/hour. The total mass of the vehicle with rider is 200 kg and the height of the centre of gravity of the vehicle with rider is 0.65 m.

PART – C **(1×15=15 Marks)**

16. a) An internal combustion engine runs at 2000 rpm. The length of the connecting rod is 24 cm and the crank radius is 6 cm. Determine at 25% of the out stroke.

i) The angular position of the crank.

ii) The angular velocity of the connecting rod.

iii) The linear acceleration of the piston.

iv) The angular acceleration of the connecting rod.

v) Linear velocity of the piston.

(OR)

b) Determine the natural frequency of transverse vibrations of a 50 mm diameter shaft simply supported at the ends 3 m apart. The shaft carries three point loads of masses 100 kg, 150 kg and 75 kg at 1 m, 2m, 2.5 m from the left support. The Young's modulus of the shaft material is 2×10^6 bar. Assume the mass of the shaft is negligible.

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Question Paper Code : 90371

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/ DECEMBER 2019
Fourth/Fifth Semester
Mechanical Engineering
ME 8594 – DYNAMICS OF MACHINES
(Common to Mechanical Engineering (Sandwich) Mechatronics Engineering)
(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Use of Drawing Sheets is Permitted.
Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Distinguish between Crank effort and Piston effort.
2. Write the expression for maximum fluctuation of energy in a flywheel.
3. Define swaying couple in partial balancing of locomotive engines.
4. What is dynamic balancing ?
5. What is viscous damping ?
6. List the methods of determining the natural frequency of the longitudinal vibrations.
7. List the sources of excitations in forced vibrations.
8. A vibrating system having mass 1 kg is suspended by a spring of stiffness 1000 N/m and it is put to harmonic excitation of 10 N. Damping factor is 0.6. Determine the amplitude of vibration at resonance.
9. State the function of the governor in an engine.
10. Define gyroscopic stabilization.

PART – B (5×13=65 Marks)

11. a) The ratio of connecting rod length to crank length of a vertical gasoline engine is 4. The engine bore and stroke is 8 cm and 10 cm respectively. The mass of reciprocating parts is 1 kg. The gas pressure on the piston is 6 bar, when it has moved 40° from the inner dead centre on its power stroke. Determine

- Net Load on the piston
- Net load on gudgeon pin and the crank piston
- Thrust on the cylinder walls
- Thrust on crank bearing

The engine runs at 2000 rpm. At what engine speed will this load on gudgeon pin at the crank pin will be zero ?

(OR)

b) The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1 mm = 4500 N-m vertically and 1 mm = 2.4° horizontally. The intercepts between output and mean resistance line taken in order from one end are 342, 230, 245, 303, 115, 232, 227 and 164 mm^2 and the engine runs at 150 rpm. If the mass of the flywheel is 1000 kg and the total fluctuation of speed does not exceed 3% of mean speed, find the radius of gyration.

12. a) Four masses A, B, C and D as shown below are to be completely balanced.

	A	B	C	D
Mass (kg)	–	40	60	50
Radius (mm)	200	250	125	140

The plane containing masses B and C are 400 mm apart. D makes angle of 210° with B and C makes angle of 90° with B in anticlockwise sense

Find

- The magnitude and the angular position of mass A,
- The position of planes A and D.

(OR)

b) The following particulars relate to an outside cylinder uncoupled locomotives.

Mass of rotating parts per cylinder	200 kg
Mass of reciprocating parts per cylinder	250 kg
Angle between cranks	90°
Crank radius	0.35 m
Cylinder centres apart	1.9 m
Diameter of driving wheel	1.85 m
Wheel centres apart	1.6 m

If the whole of rotating and two-third of reciprocating parts are to balanced in plane of the driving wheels, determine the magnitude and angular position of balance masses.

13. a) A machine mounted on springs and fitted with a dashpot has a mass 60 kg. There are three springs in parallel each of stiffness 12 N/mm. The amplitude of vibration reduces from 45 to 8 mm in two complete oscillations. Assume that the damping force varies as the velocity. Determine (a) damping coefficient (b) the ratio of frequencies of damped and undamped vibrations (c) the periodic time of damped vibration.

(OR)

b) A steel shaft ABCD 1.5 m long has flywheel at its ends A and B. The mass of flywheel A is 500 kg and radius of gyration 0.6 m. The mass of the flywheel D is 700 kg and has a radius of gyration 0.9 m. The connecting shaft has a diameter 60 mm for the portion AB which is 0.4 m long and has a diameter of 70 mm for BC which is 0.5 m long and has a diameter of d for the portion CD which is 0.6 m long. Determine i) the diameter of portion CD so that the node of the torsional vibration of the system will be at the centre of length BC and ii) Natural frequency of the torsional vibrations. The modulus of rigidity for the shaft material is 80 GN/m^2.

14. a) A body of mass of 10 kg is suspended from a spring 10 N/mm. The viscous damping causes the amplitude to decrease to one-tenth of the initial value in four complete oscillations. If the periodic force of 150 cos50t N is applied at the mass in the vertical direction, find the amplitude of forced vibrations. What is the value at resonance ?

(OR)

b) A machine weighing 700 N is mounted on springs 11 kN/cm with an assumed damping force of 0.20. A piston within the machine weighing 20 N has a reciprocating motion with a stroke of 75 mm and a speed of 3000 rpm. Assuming the piston to be simple harmonic, determine

- The amplitude of machine.
- The phase angle with respect to the exciting force.
- The transmissibility and the force transmitted to the foundation.