Dynamics of Machines ME-301-F

Important question bank:

1. State the difference between static force analysis & dynamic force analysis.
2. Write a short note on degrees of freedom.
3. What do you mean by force balancing of linkages & how this is achieved.
4. Two masses in different planes are necessary to correct dynamic imbalance. Justify this statement.
5. In what way is the inertia of the connecting rod of a reciprocal engine taken into account.
6. Explain in what way the gyroscopic couple affects the motion of an aircraft while taking a turn.
7. Explain the term stability, hunting, sensitiveness & speed range of a governor.
8. Why is inertia governor faster in response compared to centrifugal governors.
9. What is field balancing of rotors. Explain the procedure.
10. Can a single cylinder reciprocating engine be fully balanced? Justify your answer.
11. What is meant by 'Isochronism' of a governor? Define an expression for the same for Porter & Hartnell governor.
12. In a slider crank mechanism, the force acting on the slider is 2000 N. The crank radius os 30 mm & rotates in clockwise direction. The connecting rod is 60 mm long. Calculate the force on all members & driving torque at crank, when the crank has turned 60^0 counterclockwise.
13. Explain principle of superposition of force with example.
14. The following data relate to a connecting rod of a reciprocating engine. Mass=40 kg, distance between bearing centers=0.8 m, big end bearing diameter=0.08 m, small end bearing diameter=0.06 m. time for oscillation when suspended from small end 1.75 sec & from big end=1.6 sec. Determine:
    a. The M.I about the axis passing through mass center.
    b. The dynamically equivalent system of two masses, one located at small end center.
15. Derive an force analysis for static force analysis for an IC engine in terms of gas force, inertia force etc. Derive expressions for torque on crank shaft.
16. The obliquity ratio for a vertical reciprocating engine is 4.6. The engine bore & crank radius are 60 mm & 40 mm respectively. The mass of the reciprocating part is 1 kg. The difference in gas pressure acting on two sides of the piston is $5x10^5$ N/m^2 & the effective gas pressure acts downwards, towards the crank shaft, when the crank has moved 50^0 from the TDC position. Determine for a crank speed of 2000 rpm the following:
    a. The piston effort.
    b. The loads on gudgeon pin & the crank pin.
    c. The cylinder wall thrust & the thrust on the crank bearing. Neglect the inertia of connecting rod.
17. A rotating shaft carries four unbalanced masses m_1, m_2, m_3, m_4 of magnitudes 20 kg, 15 kg, 17 kg & 14 kg revolving at radii 60 mm, 80 mm, 100 mm & 60 mm respectively. The masses m_2, m_3 and m_4 revolve in planes 100 mm, 180 mm & 300 mm respectively from the plane of mass m_1 and are angularly located at 65^0, 145^0 and 270^0 respectively, measured in anticlockwise direction from mass m_1, looking from mass m_1 side of the shaft. The shaft is to be dynamically balanced by two masses both located at 70 mm radii & revolving in a plane one midway between mass m_1 and m_2 and other midway between those two masses m_3 and m_4. Determine the magnitudes of the balancing masses and their angular positions.
18. How the partial balancing of reciprocating mass is done for single cylinder engine & why partial balancing is done? What percentage of reciprocating mass is to be balanced so as to obtain overall least unbalance force?
19. The following data relates to a single cylinder reciprocating engine. Mass of the reciprocating parts 40 kg; mass of revolving parts 30 kg at 180 mm radius; speed 150 rpm; stroke 350 rpm. If 60% of the reciprocating parts and all the revolving parts are to be balanced, determine:
    a. The balancing mass required at a radius of 320 mm &

b. The unbalance force when the crank has turned 45^0 from the top dead center (TDC).

20. The cranks of a four cylinder marine oil engine are arranged at angular intervals of 90^0. The engine speed is 70 rpm & the reciprocating mass per cylinder is 800 kg. The inner cranks are 1 m apart & are symmetrically arranged between the outer cranks which are 2.6 m apart. Each crank is 400 mm long. Determine the firing order of the cylinders for the best balancing of the reciprocating masses and also the magnitude of the unbalanced primary couple for that arrangement.
21. The areas above & below the mean torque line for an IC engine are -25, +200, -100, +150, -300, +150 & -75 mm^2 taken in order. The scale for turning moment diagram 1mm vertical scale = 10 Nm & 1mm horizontal scale is 1.5^0. The mass of rotating parts are 45 kg with a radius of gyration of 150 mm. If the engine speed is 1500 rpm, find the coefficient of fluctuation of speed.
22. The mass of each ball of a Proell governor is 7.5 kg & the load on the sleeve is 80 kg. Each of the arm is 300 mm long. The upper arms are pivoted to the axis of rotation whereas the lower arms are pivoted to to links of 40 mm from the axis of rotation. The extensions of the lower arms to which the balls are attached are 100 mm long & are parallel to the governor axis at the minimum radius. Determine the equilibrium speeds corresponding to extreme radii of 180 mm & 240 mm.
23. The arms of a Hartnell governor are of equal length. When the sleeve is in mid position, the masses rotate in a circle of diameter 150 mm (the arms are vertical in mid position). Neglecting friction, the equilibrium speed for this position is 360 rpm. Maximum variation of speed taking friction into account is to be +/- 6% of the mid position speed for a maximum sleeve movement of 30 mm. The sleeve mass is 5 kg & the friction in the sleeve is 35 N. Assuming the power of the governor is sufficient to overcome the friction by 1% change of speed on each side of the mid position, find (neglecting the obliquity of the arm),
    a. The mass of each rotating ball
    b. The spring stiffness
    c. The initial compression of the spring.
24. The turbine rotor of a ship has a mass of 2.2 tonnes & rotates at a speed of 1800 rpm clockwise when viewed from aft position. The radius of gyration of the rotor is 320 mm. Determine the gyroscopic couple & its effect when (a) the ship turns right at a radius of 250 m with a speed of 25 km/h, (b) the ship pitches with the bow rising at an angular velocity of 0.8 rad/s and (c) the ship rolls at an angular velocity of 0.1 rad/s.
25. A 2.2 tonne racing car has a wheel base of 2.4 m & a track of 1.4 m. The center of mass of the car lies at 0.6 m above the ground & 1.4 m from the rear axle. Equivalent mass of engine parts is 140 kg with radius of gyration of 150 mm. The rear axle ratio is 5. The engine shaft & flywheel rotates clockwise when viewed from front. Each wheel has a diameter of 0.8 m and a moment of inertia of 0.7 $kg.m^2$. Determine the load distribution on the wheels when the car is rounding a curve of 100 m radius at a speed of 72 km/hr to the (a) left side (b) right side.