3 Hours (80 Marks)

N.B.: (1) All questions carry equal marks.

(2) Question No.1 Compulsory.

(3) Attempt any three from remaining five questions.

(3) Figures to the right indicate full marks.

(4) Draw neat sketches wherever necessary.

1. Write short notes on the following. **(Any four)** (20)

   (a) Explain multiplate clutch with diagram.

   (b) What are dry and wet Cylinder liners? What are the desirable properties of Cylinder materials?

   (c) Explain constant mesh type gearbox with neat diagram.

   (d) Enlist different types of layout.

   (e) Explain construction and working of differential.

   (f) Explain design consideration of clutch.

2. (a) Design a cast iron piston for a single acting four stroke for the following data:

   Cylinder bore = 120 mm;

   Stroke = 150 mm;

   Maximum gas pressure = 6 N/mm^2

   Indicated mean effective pressure = 0.8 N/mm^2;

   Mechanical efficiency = 80%

   Fuel consumption = 0.15 kg per brake power per hour;

   Higher calorific value of fuel = 42×10^3 kJ/kg;

   Speed = 2000 r.p.m.

   Any other data required for the design may be assumed. (12)

   (b) Explain Mac Pherson strut type suspension in detail. (08)

3. (a) A car weighs 12 kN and has wheel base of 2.5 meters. The centre of gravity of car is 1.2 m in front of rear axle and 800 mm above the ground level. The car is having brakes on all the four wheels. The coefficient of adhesion between road and wheels is 0.5. If the car is moving on level road,

   Calculate

   a) Load distribution between front and rear wheels

   b) Distance at which it can be stopped while going at a speed of 60 km/hr when only rear wheel brakes are used.

   c) Distance at which it can be stopped while going at a speed of 80 km/hr when only front wheel brakes are used. (12)

   (b) What is necessity of steering system? Explain Ackerman steering mechanism with Diagram. (08)

4. (a) A multiplate clutch consists of 2 steel disc with one bronze disc. The inner and
    Outer diameters of contacting surfaces are 200mm & 250mm respectively. The
    Coefficient of friction is 0.25 & maximum pressure between contacting surface
    is limited to $0.4N/mm^2$. Assuming uniform wear theory. Calculating required force
    to engage the clutch and torque transmitted. (10)
    (b) What are the forces acting on connecting rod? (5)
    (c) Explain self-locking and self-energizing brakes? (5)

5. (a) Explain front engine front wheel drive with its advantages and disadvantages. (10)
    (b) The propeller shaft has to transmit 171.5 Nm torque and the bottom gear ratio is 3.
    Find the diameter of the shaft. Assume a safe shear stress of 3300 Kg/cm^2. (10)

6. Write a short note on: **(any four)**
    (a) Torque converter (5)
    (b) Hotchkiss drive (5)
    (c) Front end wheel geometry. (5)
    (d) Torsion Bar. (5)
    (e) UV joint. (5)

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Duration: 3 Hours   **[Total Marks: 80]**

Instructions :
[1] Question No.**1 is compulsory**.
[2] Answer **any three** from the remaining five questions.
[3] Assume suitable data whenever required with proper justification.
[4] Answers to questions should be grouped and written together.
[5] Figures to the right indicate full marks.

Q.1   **Attempt any four of the following. All sub-questions carry equal marks**   **20**
- **(a)** What are the steps followed in vibration analysis? Briefly explain.
- **(b)** Draw a plot of Transmissibility ratio versus Frequency Ratio curves for various values of damping factor. Write the related formula. State the conclusions that may be drawn from the plot.
- **(c)** Write short note on Raleghyr's method.
- **(d)** A spring-mass system has a natural period of 0.25 second .What will be the new period of the Spring constant is: (1) increased by 50% (2) decreased by 25%?
- **(e)** Describe static and dynamic balancing of multi rotor system in details.

- **(f)**   (i)   Explain Critical speed of single rotor damped system.

Q.2   **(a)** Determine parameters for an equivalent system analysis of figure 1 using θ,   **10**
the clockwise angular displacement of the bar from the system's
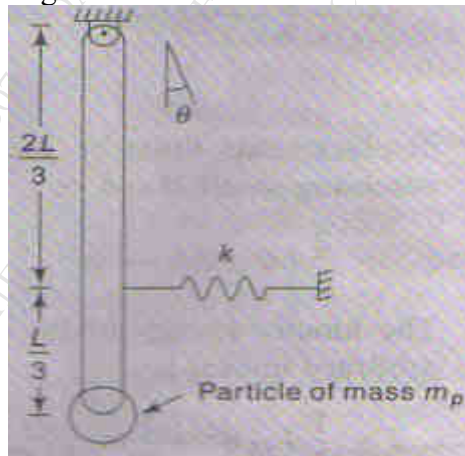equilibrium position, as the generalized coordinate. Assume small θ.

Fig. 1

- **(b)** For what value of 'C' is the damping ratio of the system of fig. 2 equal to   **10**
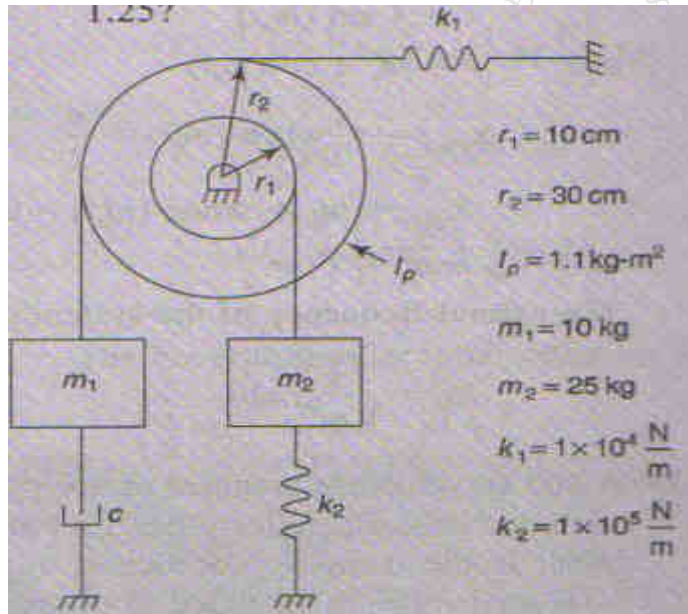1.25

Fig. 2

Q.3 (a) A spring mass damper system, having an undamped natural frequency of 100 Hz and a damping constant of 25 Ns/m, is used as an accelerometer to measure the vibration of a machine operating at a speed of 3000 rpm. If the actual acceleration is 10 m/s^2 and the recorded acceleration is 9 m/s^2, find the mass and the spring constant of an accelerometer. **10**

(b) The tail rotor section of the helicopter of the fig. 3 shown consists of 4-blades each of mass 2.3 kg and an engine box of mass 28.5 kg. The centre of gravity of each blade is 170 mm from the rotational axis. The tail section is connected to the main body by an elastic structure. The natural frequency of tail section is observed as 135 rad / sec. During flight the rotor operates at 900 rev/min. What is the vibration amplitude of the tail section? If one of the blades falls of during flight. Assume a damping ratio of 0.05 **10**

Fig.3 (Tail rotor of helicopter)

Q.4 (a) A vehicle has a mass of 1200 kg; The suspension system has a spring constant of 400 KN/m and damping ratio 0.5. If the vehicle speed is 100 Km/hr, determine the displacement amplitude of vehicle. The road surface varies sinusoidally with amplitude of 0.05 m and wavelength of 6m. **10**

(b) Explain primary and secondary forces in balancing of reciprocating engine. **05**

(c) How do you find the response of a viscously damped system under rotating unbalanced? **05**

Q.5 (a) 30 N at 20cm, 20 N at 40cm, 10 N at 60cm from fixed end are the loading on a cantilever. The deflection under 10 N due to all loads is 2mm. Find the natural frequency of oscillation of the system using Dunkerly's and Reileigh's methods. The deflection at section i due to unit load at section j is given by, **15**

$$U_{ij} = \frac{s_i^2}{constant}(3S_j - S_i) \quad \text{for } S_i \geq S_j$$

$U_{ij} = U_{ji}$, S is the distance from fixed end

(b) Define whirling speed. Derive the equation for the critical speed of a light **05** shaft with a single disc without damping.

Q.6 **(a)** A four cylinder in-line marine engine has cranks at interval of 90^0. The **10** speed of engine is 200 rpm. Each crank has 600 mm long and mass of reciprocating parts of each cylinder is 200 Kg. The outer cylinders are 4 m apart and inner cylinders are 2 m apart and are placed symmetrically between the outer cranks. Determine the firing order of the cylinders for the best balancing of the reciprocating masses. What would then be the magnitude of unbalanced primary couple?

(b) A machine of mass 55 Kg operates at 1000 rpm. Find the maximum **10** stiffness of an isolator that provides 78 percent isolation. Assume that damping ratio of the isolator is 6.5 percent.

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