

**B.E. MECHANICAL ENGINEERING, THIRD YEAR, FIRST SEMESTER EXAM 2025**

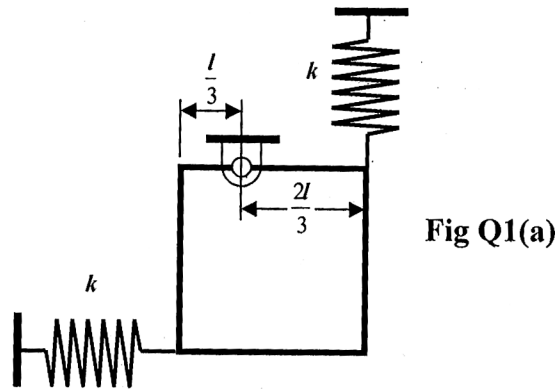
Time : Three hours

**Dynamics of Machines**

Full Marks : 100

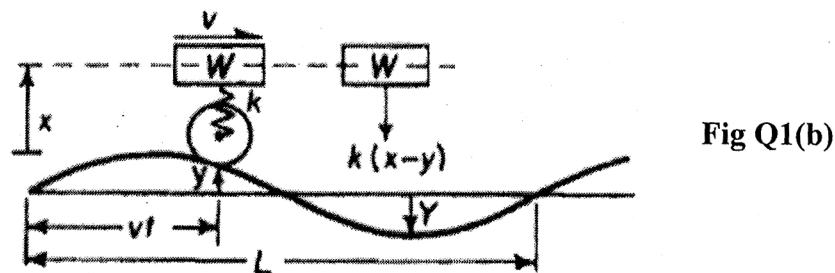
*Answer Any Five (5). Assume All Missing Data, if any, with proper justifications*

**Q1(a)** Find the **natural frequency** of the following system consisting of a laminar uniform square plate of mass  $M$  hinged freely as shown in the figure for its small oscillation in a **vertical** plane. Refer to **FigQ1(a)** 10



**Q1(b)** The following figure represents a simplified diagram [Fig Q1(b)] of a spring supported vehicle travelling over a rough road. Determine the amplitude of the lumped mass (weight of which is shown as  $W$ ) as a function of speed.

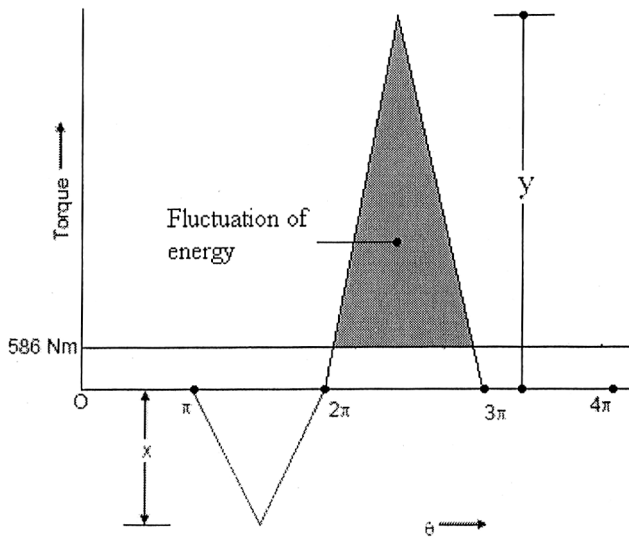
The springs of an automobile trailer are compressed **100 mm** under its weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude **80 mm** and wavelength **15m**. What will be the amplitude at **65 km/hour**? 10



**Q2** A **single cylinder four-stroke** petrol engine develops **18.4 kW** power at a mean speed of **300 rpm** (See Fig Q2). The work done during suction and exhaust strokes can be neglected. The work done by the gases during explosion strokes is **3 times** the work done on the gases during the compression strokes and they can be represented by triangles. Determine the moment of

[ Turn over

inertia of the flywheel to prevent a fluctuation of speed greater than **2%** from the mean speed on each side. **Deduce any formula you have used in your calculations.** **20**

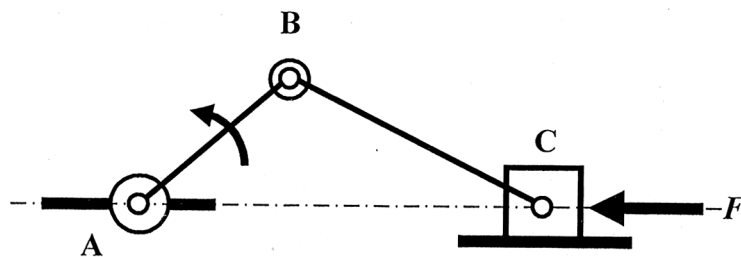


**Fig Q2**

**Q3** Consider a two-cylinder V-engine with V angle  $2\alpha$ . Find out the expressions for vertical and horizontal components of primary and secondary forces.

Comment on balancing of a  $90^\circ$  V engine. What happens to the unbalanced force when V angle is  $60^\circ$  and  $180^\circ$ ? **12+8= 20**

**Q4.** A reciprocating mechanism  $ABC$  is shown in **Fig Q4**. If  $m$  represents the effective mass of its reciprocating parts and  $r$  and  $l$  represent the lengths of  $AB$  and  $BC$  respectively, find the expressions of the torque  $T$  and the normal reaction force  $N$  between the mechanism and its supports as functions of the **angle BAC** when a force  $F$  acts on the piston C. Neglect masses of the links. Assume  $AB$  is rotating uniformly at the rate of  $\omega$  radian per second as shown in the figure. **20**



**Fig Q4**

**Q5** What is “**Firing Order**” in multi-cylinder engines?

Consider an **in-line two-stroke, five-cylinder** engine with **firing order 1-4-3-2-5**. Analyse the state of primary and secondary, force and couple balance of the engine. Assume all units are identical and are equi-spaced.

**Q6.** Justify the following statements with clear reasonings (Any **Five**):

**5×4=20**

- (a) A machine or a structure is having always some amount of damping inspite of its dissipative property.
- (b) From the free vibration response of a dynamic system, estimation of the amount of damping present can be done.
- (c) A single cylinder reciprocating engine cannot be completely dynamacally balanced.
- (d) Flywheel is essesntial in a reciprocating machine.
- (e) Number of cylinders in high-speed radial engines for the purpose of dynamic balancing is preferably an even number.
- (f) Setting appropriate firing order is an active tool for balancing of in-line engines.