Bachelor of Mechanical Engineering-Third Year, First Semester, 2024

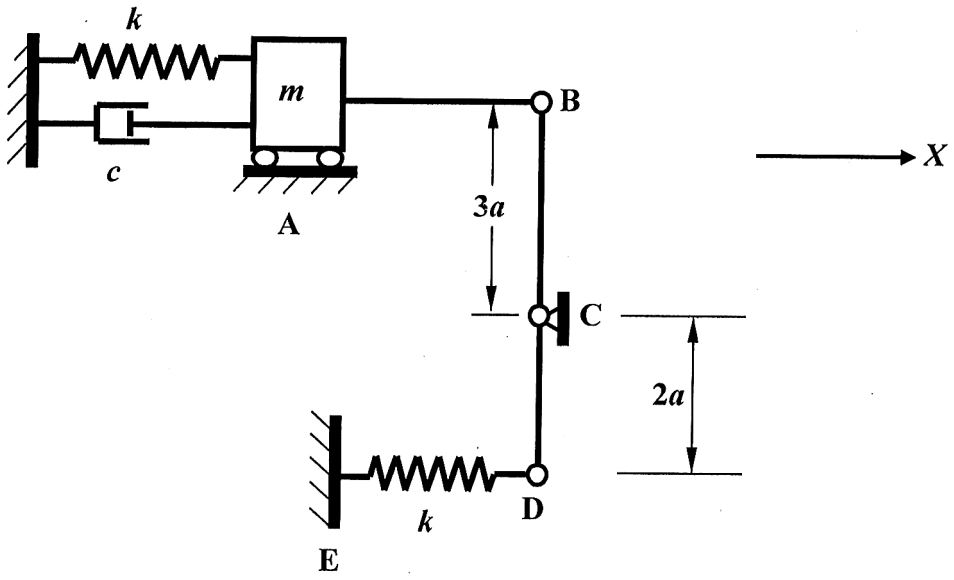
Dynamics of Machines

Full Marks: 100 **Writing Time: 3.0 Hours**

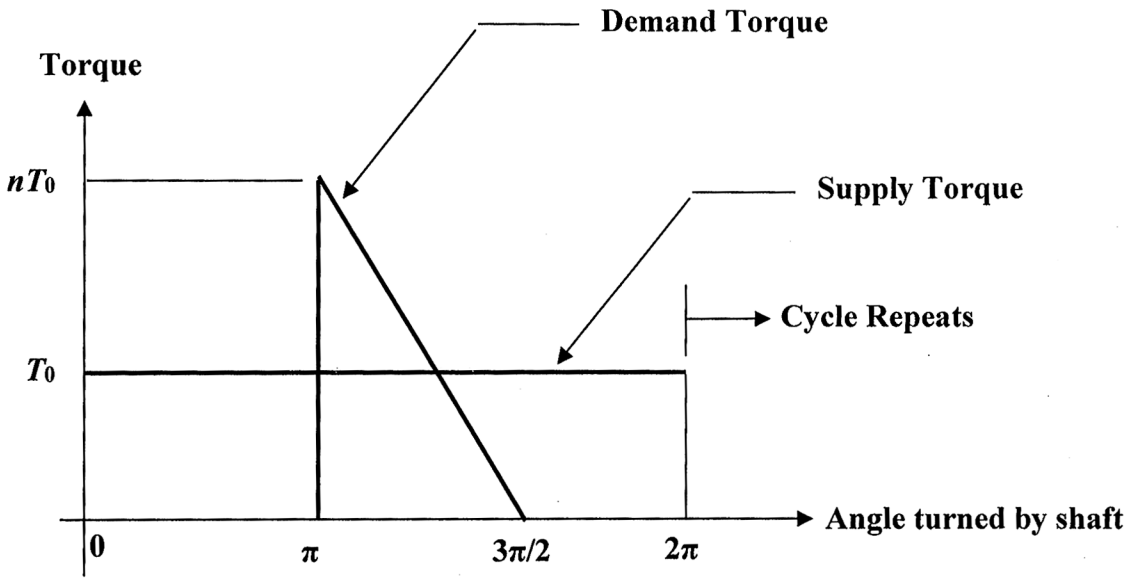
Answer Any Five (5) Questions. All questions carry equal marks

[Assume any missing data with proper justifications]

Q1. For the system shown in the figure below, find translational displacement of mass block at **A** as a function of time, if the support at **E** is given a *simple harmonic motion*: $x_1 = X_1 \sin \omega t$. Find the amplitude of response of **A**, X_2, when $\omega = 3\omega_n$ where ω_n is the natural frequency of the system. What will be the corresponding value for very light damping of the system? **BCD** is a massless lever pivoted at **C** and is free to rotate about it. Neglect the mass of all other links shown in the figure. The damping coefficient c used in the system be given by: $\sqrt{13mk}$. Is the given system over-damped or under-damped?



Q2. The following figure shows the **cyclical** variation of demand and supply torque against rotation of the shaft for an engine. Find the value of n. Name the device which you need to connect to the system in order to reduce the variation of the shaft mean speed rotation from its mean value (ω_0) by ± **1%.** What is the relevant property of the device by which this speed variation can be controlled? Find its value using the given parameters. With suitable assumption, find the driving power requirement of the engine.



Q3. Why it is said that a reciprocating engine can never be balanced?

For a horizontal single-cylinder reciprocating engine having crank radius r and connecting rod length l, derive the expression of net torque assuming gas torque (taking gas force as F_g) and the inertia torque are only significant terms. Assume the mass of the reciprocating parts is m and the crank shaft is turning uniformly at ω rad/s. Neglect the effect of all other masses in your derivation. **No sketchy derivation will be accepted.**

Q4. Following data apply to a single-cylinder vertical reciprocating machine which is mounted on a steel chasis frame whose mass is negligible:

Total Mass of the engine = **200 Kg**

Mass of the reciprocating parts = **9 Kg**

Vertical static deflection of the chasis frame due to weight of the machine = **2.4 mm**

Stroke length = **160 mm** (with simple harmonic motion)

Viscous damping coefficient = **1N·s/mm**

Calculate the following:

(**a**) Amplitude of forced vibration if the driving shaft rotates uniformly at **500 rpm**

(**b**) The speed of the driving shaft, expressed in rpm, at which resonance will occur

(**c**) The Transmissibility Ratio

Q5. Why Correction torque is required in reciprocating engine force analysis? Derive its expression with neat FBD and proper explanation. **No sketchy derivation will be accepted**.

Q6. Investigate the complete balancing status of a **two-stroke, vertical, in-line, petrol engine** with **firing order 1-3-4-2**. Assume all engine units are identical and are equi-spaced over the common engine crank shaft. If any force/couple is unbalanced, find its maximum value and the corresponding crank angle rotations. The engine is 4-cylinder.