Seat No: _____________ Enrollment No: ___________________

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

M.Tech., Winter 2017 - 18 Examination

Semester: 2 **Date: 09/01/2018**
Subject Code: 03209152 **Time: 02:00 pm to 04:30 pm**
Subject Name: Structural Dynamics **Total Marks: 60**

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1 (A) Derive the equation governing the free motion of a simple pendulum, which consists of a point mass m suspended by a light string of length L. **(05)**

(B) Explain the undamped system for the SDOF system and also explain the displacement-time curve with suitable figure. **(05)**

(C) Explain the single-degree-of-freedom system. **(05)**

Q.2 **Answer the following questions**. (Attempt any three) **(15)**

(A) Explain in brief Force-Displacement relation with appropriate figure.

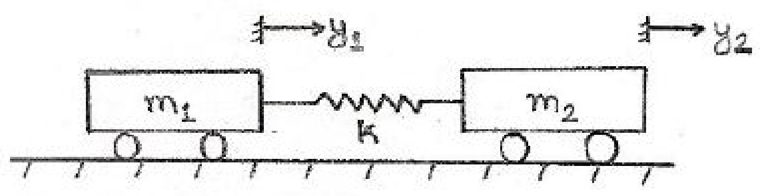
(B) What do you mean by Time Stepping Methods? Explain Central Difference Method in detail with relevant equations.

(C) What do you understand by Fatigue? Explain different stages of fatigue.

(D) Briefly discuss harmonic vibration with viscous damped system.

Q.3 (A) Derive the equation for undamped forced vibration for single degree of freedom system. **(07)**

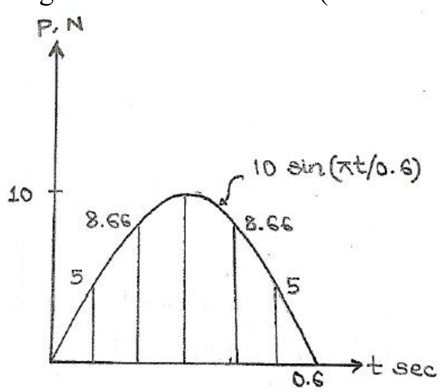
(B) A system shown in Figure 2 is modelled by two freely vibrating masses m1 and m2 interconnected by a spring having a constant "k". Determine differential equation of motion for the relative displacement u = y2 – y1 between the two masses for this system. Also determine the corresponding natural frequency of the system. **(08)**



OR

(B) Determine the expression for natural frequency and draw the mode shapes for a uniform beam when both the ends of beam are simply supported. **(08)**

Q.4 (A) An SDF system has the following properties: m=0.2533 N-sec^2/m, k=10 N/m, T_n=1 sec (ω_n= 6.283 rad/sec), and ζ = 0.05. Determine the response u(t) of this system to p(t) defined by half cycle sine pulse force shown in Figure by the Average acceleration method (Newmark's Method) using Δt = 0.1 sec. **(07)**



Special cases

(1) Average acceleration method ($\gamma = \frac{1}{2}, \beta = \frac{1}{4}$)

(2) Linear acceleration method ($\gamma = \frac{1}{2}, \beta = \frac{1}{6}$)

1.0 *Initial calculations*

1.1 $\ddot{u}_0 = \dfrac{p_0 - c\dot{u}_0 - ku_0}{m}$.

1.2 Select Δt.

1.3 $\hat{k} = k + \dfrac{\gamma}{\beta \Delta t}c + \dfrac{1}{\beta(\Delta t)^2}m$.

1.4 $a = \dfrac{1}{\beta \Delta t}m + \dfrac{\gamma}{\beta}c$; and $b = \dfrac{1}{2\beta}m + \Delta t\left(\dfrac{\gamma}{2\beta} - 1\right)c$.

2.0 *Calculations for each time step, i*

2.1 $\Delta\hat{p}_i = \Delta p_i + a\dot{u}_i + b\ddot{u}_i$.

2.2 $\Delta u_i = \dfrac{\Delta\hat{p}_i}{\hat{k}}$.

2.3 $\Delta\dot{u}_i = \dfrac{\gamma}{\beta \Delta t}\Delta u_i - \dfrac{\gamma}{\beta}\dot{u}_i + \Delta t\left(1 - \dfrac{\gamma}{2\beta}\right)\ddot{u}_i$.

2.4 $\Delta\ddot{u}_i = \dfrac{1}{\beta(\Delta t)^2}\Delta u_i - \dfrac{1}{\beta \Delta t}\dot{u}_i - \dfrac{1}{2\beta}\ddot{u}_i$.

2.5 $u_{i+1} = u_i + \Delta u_i,\ \dot{u}_{i+1} = \dot{u}_i + \Delta\dot{u}_i,\ \ddot{u}_{i+1} = \ddot{u}_i + \Delta\ddot{u}_i$.

3.0 ***Repetition for the next time step.*** **Replace i by $i + 1$ and implement steps 2.1 to 2.5 for the next time step.**

OR

(A) An SDF system has the following properties: m=0.2533 N-sec2/m, k=10 N/m, T_n=1 sec (ω_n= 6.283 rad/sec), and ζ = 0.05. Determine the response u(t) of this system to p(t) defined by half cycle sine pulse force shown in Question 4 (a) figure by the Central difference method using Δt = 0.1 sec. **(07)**

1.0 *Initial calculations*

1.1 $\ddot{u}_0 = \dfrac{p_0 - c\dot{u}_0 - ku_0}{m}$.

1.2 $u_{-1} = u_0 - \Delta t\dot{u}_0 + \dfrac{(\Delta t)^2}{2}\ddot{u}_0$.

1.3 $\hat{k} = \dfrac{m}{(\Delta t)^2} + \dfrac{c}{2\Delta t}$.

1.4 $a = \dfrac{m}{(\Delta t)^2} - \dfrac{c}{2\Delta t}$.

1.5 $b = k - \dfrac{2m}{(\Delta t)^2}$.

2.0 *Calculations for time step i*

2.1 $\hat{p}_i = p_i - au_{i-1} - bu_i$.

2.2 $u_{i+1} = \dfrac{\hat{p}_i}{\hat{k}}$.

2.3 If required: $\dot{u}_i = \dfrac{u_{i+1} - u_{i-1}}{2\Delta t}$, $\ddot{u}_i = \dfrac{u_{i+1} - 2u_i + u_{i-1}}{(\Delta t)^2}$.

3.0 *Repetition for the next time step*

Replace i by $i + 1$ and repeat steps 2.1, 2.2, and 2.3 for the next time

(B) A concrete beam of 10m span is having self-weight of 750 kg/m. The modulus of elasticity of concrete is 22000 N/mm2. Take moment of inertia of beam as 2.9 x 109 cm4. Assume that the total weight is lumped at centre of beam. Find out the frequency of vibration and time period. **(08)**