ME 2307 – DYNAMICS LABORATORY

LIST OF EXPERIMENTS

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EX NO:1: TRANSVERSE VIBRATION - I

Aim: To find the natural frequency of transverse vibration of the cantilever beam.
Apparatus required: Displacement measuring system (strain gauge) and Weights

Description:

Strain gauge is bound on the beam in the form of a bridge. One end of the beam is fixed and the other end is hanging free for keeping the weights to find the natural frequency while applying the load on the beam. This displacement causes strain gauge bridge to give the output in milli-volts. Reading of the digital indicator will be in mm.

Formulae used:

1. Natural frequency = $1/2\pi\sqrt{(g/\delta)}$ Hz
   where g= acceleration due to gravity in m/s^2 and δ = deflection in m.

2. Theoretical deflection $\delta = Wl^3/3EI$
   Where, W= applied load in Newton, L= length of the beam in mm
   E= young's modules of material in N/mm^2, I= moment of inertia in $mm^4 = bh^3/12$
3. Experimental stiffness = W/δ N-mm and Theoretical stiffness = $W/\delta = 3EI/l^3$ N/mm

Procedure:

1. Connect the sensors to instrument using connection cable.
2. Plug the main cord to 230v/ 50hz supply
3. Switch on the instrument
4. Keep the switch in the read position and turn the potentiometer till displays reads "0"
5. Keep the switch at cal position and turn the potentiometer till display reads 5
6. Keep the switch again in read position and ensure at the display shows "0"
7. Apply the load gradually in grams
8. Read the deflection in mm

Graph:

Draw the characteristics curves of load vs displacement, natural frequency
Draw the characteristics curves of displacement vs natural frequency

Result:

Observation: Cantilever beam dimensions**:** Length=30cm**,** Breadth=6.5cm **and** Height=0.4cm

Tabulation:

Sl. No.	Applied mass m (kg)	Deflection δ (mm)	Theoretical deflection δ_T (mm)	Experimental Stiffness k (N/mm)	Theoretical Stiffness k (N/mm)	Natural frequency fn (Hz)

EX NO:2 CAM ANALYSIS

Aim:

To study the profile of given can using cam analysis system and to draw the displacement diagram for the follower and the cam profile. Also to study the jump-speed characteristics of the cam & follower mechanism.

Apparatus required: Cam analysis system and Dial gauge

Description:

A cam is a machine element such as a cylinder or any other solid with a surface of contact so designed as to give a predetermined motion to another element called the follower.A cam is a rotating body importing oscillating motor to the follower. All cam mechanisms are composed of at least there links viz: 1.Cam, 2. Follower and 3. Frame which guides follower and cam.

Specification :

Diameter of base circle =150mm, Lift = 18mm, Diameter of cam shaft = 25mm
Diameter of follower shaft = 20 mm, Diameter of roller = 32mm, Dwell period = 180
Type of follower motion = SHM (during ascent & descent)

Procedure:

Cam analysis system consists of cam roller follower, pull rod and guide of pull rod.

1. Set the cam at 0° and note down the projected length of the pull rod
2. Rotate the can through 10° and note down the projected length of the pull rod above the guide
3. Calculate the lift by subtracting each reading with the initial reading.

Jump-speed:

1. The cam is run at gradually increasing speeds, and the speed at which the follower jumps off is observed.
2. This jump-speed is observed for different loads on the follower.

Graph:

Displacement diagram and also the cam profile is drawn using a polar graph chart.
The Force Vs Jump-speed curve is drawn.

Result.

Tabulation:

1.Cam profile

Sl. No.	Angle of rotation (degrees)	Lift in mm	Lift + base circle radius (mm)

2. Jump-speed.

Sl. No.	Load on the Follower, F (N)	Jump-speed N (RPM)

EX NO:3 TRANSVERSE VIBRATIONS - II

Aim: To study the transverse vibrations of a simply supported beam subjected to central or offset concentrated load or uniformly distributed load.
Apparatus Required: Trunnion bearings, beams, weights.
Set-up:

Procedure:

1. Fix the beam into the slots of trunnion bearings and tighten.
2. Add the concentrated load centrally or offset, or uniformly distributed.
3. Determine the deflection of the beam for various weights added.

Formulae used:
Defection at the center, $\delta_T = Wl^3/48EI$ for central concentrated load.
Defection at the load point, $\delta_T = Wa^2b^2/3EIl$ for offset concentrated load.
Defection at the center, $\delta_T = 5wl^4/384EI$ for uniformly distributed load.

$I = bd^3/12$; b = width of the beam, d = depth of the beam, l = length of the beam.
Natural frequency of transverse vibrations, $f_n = 1/2\pi\sqrt{(g/\delta)}$ Hz
where g= acceleration due to gravity in m/s^2 and δ = deflection in m.

Observations: b = , d = , l = , E =

Tabular column:

Sl. No.	Mass added m , kg	Experimental Deflection δ, m	Theoretical Deflection δ_T, m	Theoretical Nat. freq. f_n, Hz	Experimental Stiffness K, N/m	Theoretical Stiffness K, N/m

Graphs:
1. Deflection Vs. load (N) from this get stiffness (graph)
2. Deflection Vs. Natural frequency
3. Load in N Vs. natural frequency

Stiffness experimental, K = load/deflection $= W/\delta = mg/\delta$ N/mm
Stiffness theoretical, $K = W/\delta_T = 48EI/l^3$ for center load,
$= 3EIl/a^2b^2$ for offset load,
$= 384EI/5l^3$ for uniformly distributed load,

Diagrams: Simply Supported beam with the given load and parameter.

EX NO:4 FREE VIBRATION OF SPRING-MASS SYSTEM

Aim: To calculate the undamped natural frequency of a spring mass system
Apparatus required: Weights, Thread, Ruler, Stopwatch
Description:

The setup is designed to study the free or forced vibration of a spring mass system either damped or undamped condition. It consists of a mild steel flat firmly fixed at one end through a trunnion and in the other end suspended by a helical spring, the trunnion has got its bearings fixed to a side member of the frame and allows the pivotal motion of the flat and hence the vertical motion of a mass which can be mounted at any position along the longitudinal axes of the flat. The mass unit is also called the exciter, and its unbalanced mass can create an excitational force during the study of forced vibration experiment. The experiment consists of two freely rotating unbalanced discs. The magnitude of the mass of the exciter can be varied by adding extra weight, which can be screwed at the end of the exciter.

Formula used

Stiffness, k = load/deflection N/m
Experimental natural frequency, $f_{n(exp)} = 1/t$ Hz
Theoretical natural frequency, $f_{n(the)} = 1/2\pi\sqrt{(g/\delta)}$ Hz

Procedure

Determination of spring stiffness

1. Fix the top bracket at the side of the scale and Insert one end of the spring on the hook.
2. At the bottom of the spring fix the other plat form
3. Note down the reading corresponding to the plat form
4. Add the weight and observe the change in deflection
5. With this determine spring stiffness

Determination of natural frequency

1. Add the weight and make the spring to oscillate for 10 times
2. Note the corresponding time taken for 10 oscillations and calculate time period
3. From the time period calculate experimental natural frequency

Calculation:
Graph:

Load vs Deflection
Load vs Theoretical natural frequency
Load vs Experimental natural frequency

Result:
Tabulation:

Sl no	Weight added m (kg)	Deflection δ (mm)	Stiffness k (N/m)	Time for 10 oscillation t (sec)	Time period T (sec)	Experimental natural frequency, $f_{n(exp)}$, Hz	Theoretical natural frequency $f_{n(the)}$, Hz

EX NO:5 COMPOUND PENDULUM

Aim: To determine the radius of gyration and mass moment of inertia of the given rectangular rod experimentally.

Apparatus required: 1. Vertical frame, 2. Rectangular rod, 3. Stop watch and 4. Steel rule etc

Procedure:

1. Suspend the rod through any one of the holes
2. Give a small angular displacement to the rod & note the time taken for 5 oscillations
3. Repeat the step by suspending through all the holes.

Formulae used:

Time period T= t/N sec and also Experimental time period $T = 2\pi\sqrt{((K^2+L_1^2)/gL_1)}$

Where K= experimental radius of gyration and $K = \sqrt{((gL_1T^2/4\pi^2)-L_1^2)}$,

L_1= distance from point of suspension to centre of gravity of rod and L= total length of the rod

Theoretical radius of gyration, $K_t = L/\sqrt{12}=0.2866L$

Natural frequency fn = 1/T (Hz) and Moment of inertia $I_m = mk^2$ kg-m^2

Result:

Tabulation:

Sl. No.	Distance L_1 (m)	Time for 5 oscillations t (sec)	Time period T (sec)	Natural frequency fn (Hz)	Experimental radius of gyration (K_{exp})

Calculation:

EX NO:6 BIFILAR SUSPENSION

Aim: To determine the radius of gyration and the moment of Inertia of a given rectangular plate.

Apparatus required: Main frame, bifilar plate, weights, stopwatch, thread

Formula used:

Time period T=t/N
Natural frequency fn = 1/T hz
Radius of gyration $k = (Tb/2\pi)\sqrt{(g/L)}$ (mm)
Where, b=distance of string from centre of gravity, T= time period
L= length of the string, N= number of oscillations
t= time taken for N oscillations

Procedure:

1. Select the bifilar plate
2. With the help of chuck tighten the string at the top.
3. Adjust the length of string to desired value.
4. Give a small horizontal displacement about vertical axis.
5. Start the stop watch and note down the time required for 'N' oscillation.
6. Repeat the experiment by adding weights and also by changing the length of the strings.
7. Do the model calculation

Graph:

A graph is plotted between weights added and radius of gyration

Calculations:

Result:

Observation:

Type of suspension = bifilar suspension
Number of oscillation n=10
b =10.15 cm d = 4.5 cm b_1=21.5 cm

Tabulation:

Sl. No.	Weight added m (kg)	Length of string L (m)	Time taken for N osc. T sec	Natural frequency fn (Hz)	Radius of gyration k (mm)

EX. NO. 7 TRIFILAR SUSPENSION

Aim: To determine the radius of gyration of the circular plate and hence its Mass Moment of Inertia.

Apparatus required: Main frame, chucks 6 mm diameter, circular plate, strings, stop watch.

Procedure:

1. Hang the plate from chucks with 3 strings of equal lengths at equal angular intervals (120^0 each)
2. Give the plate a small twist about its polar axis
3. Measure the time taken, for 5 or 10 oscillations.
4. Repeat the experiment by changing the lengths of strings and adding weights.

Formulae used :

Time period, T = t/N, Natural frequency, fn = 1/T Hz

Radius of gyration, K = (bT/2Л) √(g/l) m.

Where b-distance of a string from center of gravity of the plate,

l- Length of string from chuck to plate surface.

Moment of inertia of the plate only, $I_p=(R^2 \text{ x } W_1) / (4\pi^2 fn^2 \text{ x } l)$

Moment of inertia with weight added ,$I_t=R^2 \text{ x } (W_1 + W) / 4\pi^2 fn^2 \text{ x } l)$

Where, R- Radius of the circular plate and W_1-Weight of the circular plate = $m_1 g$ in N m_1 = 3.5 kg

W- Weight of the added masses = mg in N

Moment of inertia of weight, $I_w = I_t - I_p$

Result: The radius of gyration of the plate and moment of inertia of the weights were determined and tabulated.

Graphs:

Weight added vs radius of gyration

Weight added vs moment of inertia

Observations:

Type of suspension:…………………, No. of oscillations …………………….

Radius of circular plate, R=…….m, mass of the plate, m_1 = ……..kg

Sl. No.	Length of string l, m	Added, mass, m, kg	Time for N oscillations, t, sec	Time period T, sec	Radius of gyration, k, m	Natural frequency f_n, Hz	Moment of inertia of weight Iw,kgm

EX. NO: 08 EQIVALENT SRING MASS SYSTEM

Aim : to determine the undamped natural frequency of an equivalent spring –mass system.
Apparatus required : Spring, trunnion, beam, extra mass, steel rule.

Procedure:

1. Attach the beam to the trunnion bracket
2. Measure the distance between pivot and spring(L_1) m
3. Mount the exciter assembly over the beam at suitable length after altering the spring at the other end (L_2) m
4. Excite the beam by a simple jerk and measure the time taken for N oscillations (t) sec
5. Repeat the experiment by changing the exciter position or mass or both.

Formulae used:

Spring stiffness, K = load/deflection = $W/\delta = mg/\delta$ N/m in (part I)
m- Mass added to spring in kg

Equivalent mass, $M_{eq} = M (L_2/L_1)$ kg, M- mass of the exciter assembly in kg
Time period, (Theoretical) $T_{the} = 2\Pi\ M_{eq}/K$ sec.
L_1- Distance between pivot and spring, m and L_2- Distance between pivot and exciter assembly, m

Theoretical natural frequency, $f_{n(the)} = 1/T_{the}$ Hz ,
Experimental natural frequency, $f_{n(exp)} = 1/T_{exp}$
Experimental time period, $T_{exp} = t/N$ sec.

Observations: Mass of the exciter assembly, M =…………..kg

Sl no	Mass of exciter assembly M, (kg)	Lengths		Time for N oscillations (t) sec	Experimental time period, T_{exp}, sec	Theoretical time period, T_{the}, sec	Experimental Natural frequency, $f_{n(exp)}$	Theoretical Natural frequency, $f_{n(the)}$
		L_1 m	L_2 m					
1								
2								
3								
4								
5								

Graphs: L_2 Vs T_{exp}, T_{the}
L_2 Vs $f_{n(exp)}$, $f_{n(the)}$
Diagrams: spring-mass system, equivalent spring mass system

EX NO:09

Aim: To verify the dunker lay's rule viz.
Apparatus Used: 1/f2 =1/fl 2 +1/fb 2
Where:-
F=natural frequency of given beam (considering the weight of beam) with central load w. Fl=natural frequency of given beam (neglecting the weight of beam) with central load
Fl=1/2π√ (48e.i.g/l3w)
Fib=natural frequency of the beam.

Description: At rectangular bar is supported in trunion fitting at each end. Each trunion is provided In a ball bearing carried in housing. Each bearing housing is fixed to the vertical Frame member. The beam carries a weight platform.

Experimental procedure:
1. Arrange the set-up as shown in fig with some wt. W clamped to wt platform.
2. Pull the platform s release it to set the system in to natural vibration.
3. Find the platform time t s frequency of vibration f by measuring time for some oscillation.
4. Repeat experiment by putting addional masses on weight platform.
5. Plot graph of 1/f2 vs.

Formula:
1. Frequency of beam, Fl=1/2π√ (48eig/l3w)
2. Natural frequency Fb=π/2√ (g.e.i/wl4)
3. Moment of inertia of beam section I=bh3 /12
4. Actual time period, Tact=t/n
5. Actual frequency, Fact=1/tact

Observation & calculation table:

S no	**Weight attached W kg**	**No. of Osc. n**	**Time for n Osc. t**	**Tact=t/n (sec)**	**Frequency Fact.(hz)**

Nomancature:
B=width of beam
E= modulus of elasticity of beam material
Fl= frequency of beam
Fb= natural frequency of beam
Fact=actual frequency

G=acceleration due to gravity..
H=thickness of beam
I=moment of inertia
L=length of the beam
N=number of oscillations
T=time taken for n oscillation
Tact=actual time period
W=weight of beam per unit length
W=central load of the beam, or weight attached.

Result:

EX NO:10

OBJECTIVE: TO VERIFY THE RELATION OF SIMPLE PENDULUM

$$T = 2\prod\sqrt{L/g}$$

Where T= Periodic time in sec.

L= Length of Pendulum in cm.

DESCRITION:

For conduction the experiment, a ball is supported by nylon thread into a chuck. It is possible to change the length of pendulum. This makes it possible to study the effect of variation of length on periodic time. A small ball may be substituted by large ball to illustrate that period of oscillating that period of oscillation is independent of the mass of ball.

UTILITIES REQUIRED:

- Pace Required : 0.90 * 1.30m
- Power supply: 220volt, single phase, 5Amp. Socket

EXPERIMENTAL PROCEDURE:

- Attach the ball to one end of the thread.
- Allow ball to oscillate and determine the periodic time T by knowing the time for say 10 oscillations.
- Repeat the experiment by changing the length.
- Complete the observation table given below.

Standard Data:

Acceleration due to gravity, g= $9.81 m/s^2$

Formulae:

1. Time Period, T_{actual} = t/n sec.

2. Time Period, $T_{theo.}$ = $2\prod\sqrt{L/g}$ sec.

Where

T = Time taken by 'n' oscillations.

N = Nos. of oscillation.

L = Length of the pendulum.

OBSERVATION AND CALCULATION TABLE:

Sr. No.	L cm.	No. Of Osco 'n'	Time for n Osco. 'T' Sec.	T sec. (Act.) t/n	T Sec. (Theo)
1. 2. 3. 4.					