Basic Parameters And Dimensions:

Table-5.1 Basic Parameters And Dimensions according to figure-5.1 & 2

Beam			
Parameter	**Value**	**Parameter**	**Value**
L(cm)	76.1	**b(cm)**	71.7
w(mm)	2.5	**t(mm)**	12.5

Motor,Rotating Disks			
Parameter	**Value**	**Parameter**	**Value**
a(cm)	32	**r(mm)**	16
e(mm)	56	**t_d(mm)**	6.5

Spring			
Parameter	**Value**	**Parameter**	**Value**
D(mm)	42.4	**d(mm)**	2.4
N(turns)	18		

Table-5.2 Data collected for the experiment

Free Vibration Part	
Parameter	**Value**
T(second)	4.3
C[from the first chart](mm)	7
V=C/10(mm/s)	15.45

Forced Vibration Part	
Parameter	**Value**
N_r(rpm)	425
N(rpm)	420
A[amplitude of tge second chart](mm)	

VIII-Results:

Table-5.3 Data processing analysis

Parameter	Value
M_b(kg)	1.753
I(kg.m^2)	0.8043
K(N/m)	241.81

Table-5.4 results by the natural frequency by the various methods

Method	Natural Frequency w_n(rad/sec)	Percent Error (%)
Analytical (E.O.M)	14.68	
Time Measurements	14.61	0.48
Drum Speed	13.87	5.52
Resonance Observation	13.6	7.36

Table-5.5 results Magnification Factor MF results

Methode-1	w(rad/sec)	r(w/w_n)	MF	Percent Error (%)
	13.44	.9155	6.176	
Methode-2	$Y_{dynamic}$(mm)	Y_{static}(mm)	MF	0.327
	3.6	0.581	6.2	

$M_b = \rho_{beam} \cdot V_{beam}$

$V_{beam} = L * W * t = 76.1 * 10^{-2} * 2.5 * 10^{-2} * 12.5 * 10^{-3} = 2.378 * 10^{-4}\ m^3$

$\rho_{beam} = 7370\ kg/m^3$

$M_b = 1.763\ kg$

$I = Ma^2 + M_b \frac{L^2}{3}$

$= (4.55)(0.32)^2 + 1.753 \frac{(0.761)^2}{3}$

$= 0.8043\ kg.m^2$

$K = \frac{G d^4}{8 N D^3}$

$= \frac{80 * 10^9 (2.4 * 10^{-3})^4}{8(18)(42.4 * 10^{-3})^3}$

$K = 241.81\ N/m$

$\omega_{n\,theor} = \sqrt{\frac{Kb}{I}} = \sqrt{\frac{(241.81)(0.717)}{0.8043}}$ b: بدون تربيع

$= 14.68\ rad/s$

time measurements :-

$\tau = T/10 = 4.3/10 = 0.43\ sec$

$\omega_n = \frac{2\pi}{\tau} = \frac{2\pi}{0.43} = 14.61\ rad/s$

$Error = \left| \frac{14.61 - 14.68}{14.68} \right| * 100\% = 0.48\ \%$

* Drum speed

$V = \frac{L}{time} = \frac{68}{4.4} = 15.45\ mm/s$

$\tau = \frac{c}{V} = \frac{7}{15.45} = 0.453\ sec$

$\omega_n = \frac{2\pi}{\tau} = 13.87\ rad/s$

$= \left| \frac{15.\ldots}{14.68} \right|$

$= 5.52\%$

* Resonance observation

$\omega = 425 \text{ rpm}$

$\omega_n = \omega * \frac{22}{72} * \frac{2\pi}{60}$

$= 13.6 \text{ rad/s}$

$\text{Error} = \left| \frac{13.6 - 14.68}{14.68} \right| * 100\%$

$= 7.36\%$

* magnification factor

$N = 420 \text{ rpm}$

$\omega = \frac{2\pi}{60} * \frac{22}{72} * 420 = 13.44 \text{ rad/s}$

$r = \frac{\omega}{\omega_n} = \frac{13.44}{14.68} = 0.9155$

$MF = \frac{1}{1-r^2} = \frac{1}{1-(0.9155)^2} = 6.176$

$m_{hole} = 2 \rho V = 2(2800)(\pi * (16*10^{-3})^2 * 6.5*10^{-3}) = 0.0293 \text{ kg}$

$Y_{static} = \frac{m e L a \omega^2}{K b^2} = \frac{(0.0293)(0.056)(0.32)(13.44)^2(0.761)}{(241.81)(0.717)^2} = 5.81*10^{-4} \text{ m}$

$Y_{dynamic} = \frac{m e a L \omega^2}{K b^2 - I_A \omega^2}$

$I_A = \ldots \quad I_{hole} = \frac{1}{2} \cdot m r^2 = 0.016^2 * 0.5 * 0.0293 = 3.75 * 10^{-6} \text{ kg.m}^2$

$\therefore Y_{dynamic} = \frac{(0.0293)(0.056)(0.32)(0.761)(13.44)^2}{(241.81)(0.717)^2 - (3.75*10^{-6})(13.44)^2} = 5.8*10^{-4} \text{ m} = 0.581 \text{ mm}$ *

$Y_{dynamic}$ from chart $= 3.6$ mm

$MF = \frac{3.6}{0.581} = 6.2$

$\text{Error}\% = \left| \frac{6.2 - 6.176}{6.176} \right| * 100\% = 0.327\%$

IX- Discussion And Conclusions:

1. What is the meaning of the Static Amplitude of oscillation? In this case, derive the expression of *(Y_{static})* given in *eqn-12*?

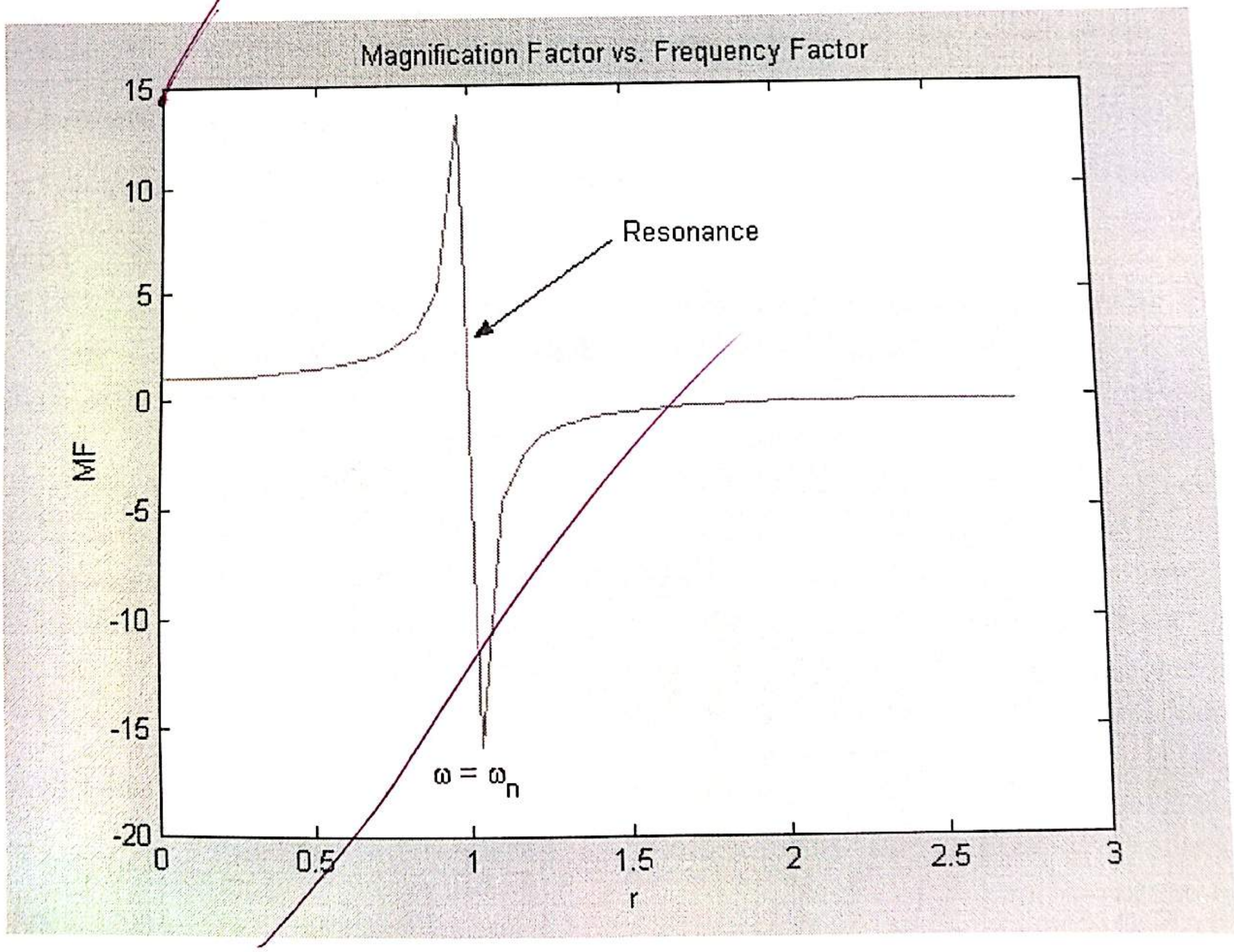
The amount of vertical deflection of the spring due to motor weight and beam weight before any initial excitation or forcedoscillation of the system starts. It can be derived from the sum of moments about the pivot point:

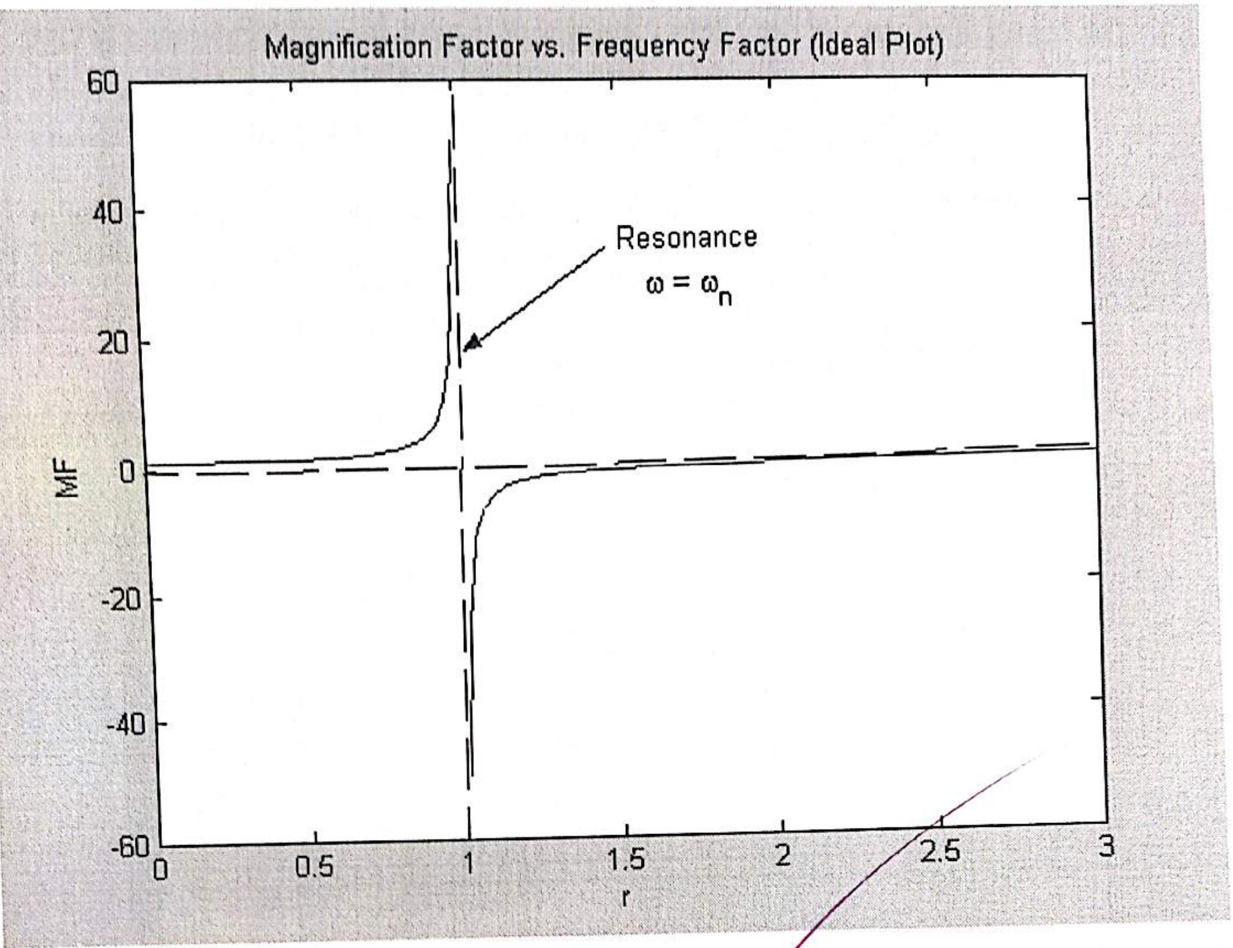
$$\sum M_O = 0$$

$$(kbY_{static})b - (me\omega^2 L)a = 0$$

$$\Rightarrow Y_{static} = \frac{meaL\omega^2}{kb^2} \ \#$$

2. Draw the magnification factor *MF* versus frequency ratio *r* for the system, for this mode of forced vibrations *(Rotating Unbalance)*?





3. According to your observations and plot in the previous question, did the amplitude of oscillations reach a very high value at resonance? If not, why?

No, it didn't reach a considerably very high value at resonance. But the amplitude was relatively high compared with proceeding or preceding amplitudes. This can be attributed to:

- Frictional losses (e.g. at pivot point).
- Hysteresis damping which can't be neglected.
- Spring internal resistance and friction.

4. In the derivation of the equation of motion for the system, why did not we consider the effect of the gravitational forces *(weights of its components)* although they have moments about point *O*?

The moments of the gravitational forces ($M_b g * 0.5L$) will cancel out with the static deflection spring force ($k\delta$) where the vibration mode is measured from the static equilibrium position.

5. For a practical system like a machine, suffering from such mode of vibrations, how could you modify its parameters *(↑ or ↓)*, or add other components, in a way that minimises vibrations level?

- Adding mass that compensates the rotational unbalancing eccentric mass.
- Minimize: 1) The distance of the motor from pivot point.
  2) The eccentricity of the hole so to reduce the amplitude external force.
  3) The radius of the disk and hole.
  4) The angular rotation of the forcing device or the motor.
- Maximize the Natural Frequency of the system by:
  1) Increasing the stiffness of the spring.
  2) Increase the cross section area of beam.