Code No: RR412101 **Set No.1**

IV B.Tech. I Semester Regular Examinations, November -2005
THEORY OF VIBRATIONS AND AEROELASTICITY
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Define simple harmonic motion and various terms associated with it. Find the equation of motion of a mass attached to a spring and oscillating in vertical direction. [16]

2. A flywheel having a mass of 35 Kg was allowed to swing as pendulum about a knife-edge at inner side of rims shown in fig1. If the measured period of oscillation was 1.22 seconds, determine the moment of inertia of the flywheel about geometrical axis. Inner radius is 0.3m and outer radius is 0 .4m.? as shown in figure 1. [16]

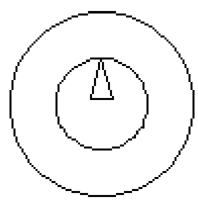

Figure 1:

3. Analysis of the oscilloscopic record of a rap test on a machine mounted on isolators reveal that the rate of decay of the amplitude is 2.5% per cycle when the amplitude is 1.5 cm and 4 % when the amplitude is 0.4 cm. Assume both coulomb as well as the viscous damping are present in the system. Determine the magnitude of the damping ratios. [16]

4. An electric motor of mass 250 kg with an unbalance of 10-2 kg is mounted on four rubber isolators, which have a material loss factor of 0.5. The rubber isolator deflects by 2.5 mm due to self-load of the motor.
   (a) What will be the amplitude of the motor at the operating speed of 990 rpm.
   (b) What will be the force transmitted to the ground at the operating speed. [16]

5. A torsional system has an inertia of 1.176 kg-m^2 and a torsional stiffness 235 N-m/rad. It is acted upon by a torsional excitation at 150 cpm. Determine the parameters of the absorber to be fixed to the main system if it is desired to keep the natural frequencies at least 20% away from the impressed frequency. [16]

6. Determine the frequency equation in transverse vibration for a uniform beam of length l having one end fixed and the other simply supported. [16]

7. The vibrations of a cantilever are given by $y=y_1(1-\cos(x/2l))$. Calculate the frequency with following data for the cantilever using Reyleigh's method. Modulus of elasticity of the material $=2\times10^{11}N/m^2$. Second moment of area about bending axis 0.02 m^4. Mass = 6×10^4 kg, length = 30 m. [16]

8. Derive the equation motion for flutter analysis in case of a swept back wing. [16]

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Code No: RR412101 **Set No.2**

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Time: 3 hours **Max Marks: 80**

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1. Consider the following harmonic motions:
   (a) X_1 =0.5 Cos(45)t , X_2=Sin(180)t
   (b) X_1= 2 Cos(180)t, X_2=2 Cos(2)t

   Is the sum (X_1+X_2), in each case, a periodic motion? If so, what is the period?[16]

2. An unknown weight W lb attached to the end of an unknown spring k has a natural frequency of 94 c.p.m. When a 1 Kg weight is added to W, the natural frequency is lowered to 76.7 c.p.m. Determine the unknown weight W Kg and the spring constant k. [16]

3. Analysis of the oscilloscopic record of a rap test on a machine mounted on isolators reveal that the rate of decay of the amplitude is 2.5% per cycle when the amplitude is 1.5 cm and 4 % when the amplitude is 0.4 cm. Assume both coulomb as well as the viscous damping are present in the system. Determine the magnitude of the damping ratios. [16]

4. What will be the frequency ratio when the amplitude in forced vibrations is maximum. Determine the peak amplitude and the corresponding phase angle. [16]

5. Derive expressions for the two natural frequencies for small oscillations of the pendulums shown in Fig2. in the plane of the paper. Assume the rods as mass less and rigid. Also obtain expressions for the angular amplitude ratios in the two modes.[16]

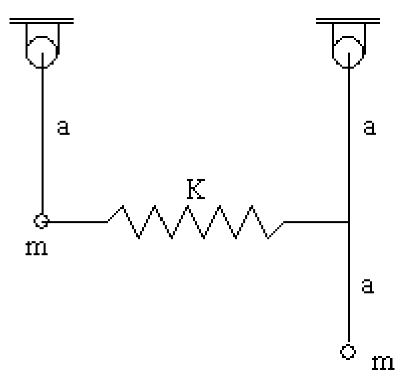

Figure 2:

6. Derive the frequency equation of longitudinal vibrations for a free-free beam with zero initial displacement? [16]

7. A four cylinder engine whose shaft is coupled to a damper at one end and a generator at the other end has a flywheel mounted on the shaft b/w the engine and the generator. The values of rotor inertias and shaft stiffness are given below fig:3[16]

J_1=10Kg-m^2
J_2= J_3= J_4= J_5=1.5Kg-m^2
J_6=20
J_7=120
K_{t1}=40*10^{6}Nm/rad
K_{t2}=K_{t3}= K_{t4}=30*10^6
K_{t5}=60*10^6
K_{t6}=10*10^6

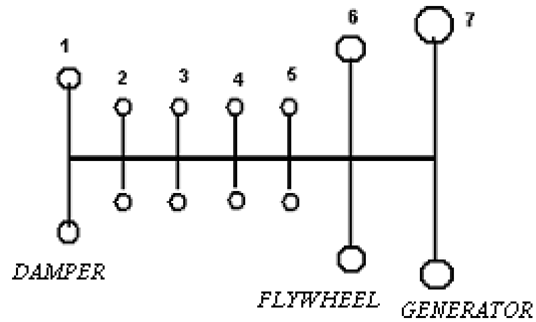

Figure 3:

8. Derive the equation motion for flutter analysis in case of a swept back wing[16]

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1. Describe the various methods for the analysis of an oscillating system and finding the equations of motion. [16]

2. Spherical body of radius r rolls without slipping on a concave spherical surface of radius of R. Find the frequency of small vibrations of the sphere about the equilibrium position. [16]

3. Analysis of the oscilloscopic record of a rap test on a machine mounted on isolators reveal that the rate of decay of the amplitude is 2.5% per cycle when the amplitude is 1.5 cm and 4 % when the amplitude is 0.4 cm. Assume both coulomb as well as the viscous damping are present in the system. Determine the magnitude of the damping ratios. [16]

4. A machine runs at 5000rpm. Its forcing frequency is very near to its natural frequency of the machine is to be at least 20% from the forced frequency, design a suitable vibration absorber of the system. Assume the mass of the machine as 30 kg.Specify the lowest frequency of a vibrometer that can be measured with 1% error, if its natural frequency is 4 Hz and damping ratio is 0.2. [16]

5. Two uniform rods AB and CD are pivoted at their upper ends as shown in figure4. Their lower ends are at the same level and are connected by a spring. Each rod weighs 5 kg/m and is vertical in equilibrium position with the spring unstrained. The spring has a stiffness of 2940 N/m. The spring is now compressed slightly and released. Find the frequency of the resulting vibrations if the effect of gravity is neglected. If AB moves through 1 degree on either side of the vertical, find the corresponding angular amplitude of CD and the maximum force in the spring.[16]

6. Derive the frequency equation of longitudinal vibrations for a free-free beam with zero initial displacement? [16]

7. An aircraft wing is educed to a series of discs & shafts for the Holzer's analysis. Determine the first tow torsional natural frequencies i.e. anti-symmetric & symmetric torsional vibrations of the wing. Plot the corresponding mode shapes? as shown in fig5 [16]

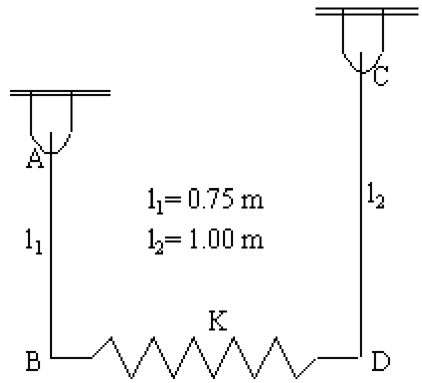

Figure 4:

(in $Kg.m^2$)	(in Nm/rad)
I1=6.2	K1=2.7
I2=17.5	K2=4.5
I3=22	K3=5.3
I4=27	K4=5.4
I5=39	K5=18
I6=10000	

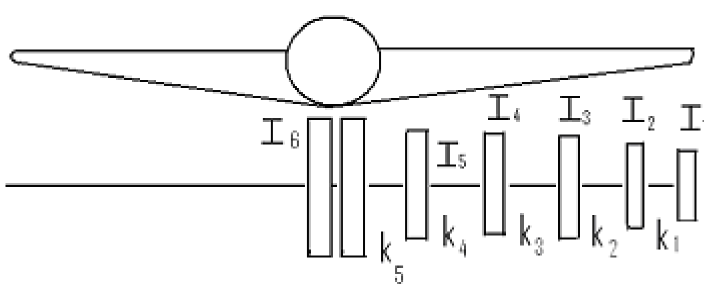

Figure 5:

8. Derive the equation motion for flutter analysis in case of a swept back wing.[16]

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1. Find the expression for the displacement of a disc attached to the end of a circular shaft whose other end is fixed. The disc is oscillating in horizontal plane and is coaxial with the shaft. [16]

2. A mass of 10 kg is supported by steel wire 1 mm in dia and 3 meters long. The system is made to move upwards with a uniform velocity of 10 cm/sec when upper end is suddenly stopped. Determine the frequency and the amplitude of the resulting vibrations of the mass and maximum stress in the wire. [16]

3. Analysis of the oscilloscopic record of a rap test on a machine mounted on isolators reveal that the rate of decay of the amplitude is 2.5% per cycle when the amplitude is 1.5 cm and 4 % when the amplitude is 0.4 cm. Assume both coulomb as well as the viscous damping are present in the system. Determine the magnitude of the damping ratios. [16]

4. A vibrometer indicates 2 percent error in the measurement and its natural frequency is 5 Hz. If the lowest frequency that can be measured is 40 Hz, find the value of damping factor. [16]

5. A torsional system has an inertia of 1.176 kg-m^2 and a torsional stiffness 235 N-m/rad. It is acted upon by a torsional excitation at 150 cpm. Determine the parameters of the absorber to be fixed to the main system if it is desired to keep the natural frequencies at least 20% away from the impressed frequency. [16]

6. A vibrating system consists of uniform simply supported beam with total mass of weight mb, rigidity EI, length l with a concentrated load m at the middle. Assuming that the deflection curve is that due to a concentrated force at the middle of beam; find the frequency of flexural vibration. [16]

7. A shaft of negligible weight 6 cm diameter and 5 meters long is simply supported at the ends and carries four weights 50 kg each at equal distances over the length of the shaft. Find the frequency of vibration by Dunkerley's method. Take E=2×10^{06} Kg/cm^2. [16]

8. Derive the equation motion for flutter analysis in case of a swept back wing. [16]

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