Hall Ticket No | | | | | | | | | | |

Question Paper Code: BCC213

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

M.Tech II Semester End Examinations (Supplementary) - January, 2019

Regulation: IARE–R16

STRESS ANALYSIS AND VIBRATION

Time: 3 Hours **(CAD/CAM)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Prove that the following Airy's stress functions and examine the stress distribution represented by them: **[7M]**
   i. $\Phi = Ax^2 + By^2$
   ii. $\Phi = Ax^3$
   iii. $\Phi = A\left(x^4 - 3x^2y^2\right)$.

   (b) Show that the Airy's stress function Φ = A (xy^3- 3/4xyh^2) represents stress distribution in a cantilever beam loaded at the free end with load P. Find the value of A if $\Gamma_{xy} = 0$ at y = ± h/2 where b and h are width and depth respectively of the cantilever. **[7M]**

2. (a) A cantilever beam of rectangular cross section 40 mm wider and 60 mm thick is 800 mm in length. It carries a load of 500N at the free end. Determine the stresses in the cantilever at mid length. **[7M]**

   (b) A steel gun barrel is subjected to an internal pressure of 70MPa. The internal diameter of the barrel is 75 mm and external diameter is 225mm. A steel band 25 mm thick and internal diameter 0.075mm smaller than the external diameter of the gun barrel is shrunk on to the gun barrel. Calculate (a) the shrinkage pressure on the gun barrel, (b) maximum stress in the steel band, and (c) minimum temperature to which the band must be heated to make the assembly. **[7M]**

UNIT – II

3. (a) A square shaft rotating at 250rpm transmits torque to a crane which is designed to lift maximum load of 150KN at a speed of 10m/min. If the efficiency of crane gearing is 65%, estimate the size of the shaft for maximum permissible shear stress of 35MPa. Also calculate the angle of twist of the shaft for a length of 3m. Take G=100 GPa. **[7M]**

   (b) A steel turbine rotor of 750 mm outer diameter, 150 mm inner diameter and 50mm thickness, has 100 blades 150 mm long, each weighing 4 N. It is shrinking – fitted on a rigid shaft. Calculate the initial shrinkage allowance on the inner diameter of the rotor so that it just loosens on the shaft at 3000 rev/ min. Take E= 200 GPa, = 0.3. The density of shaft rotor is 7500kg/m^3 **[7M]**

4. (a) Derive equations of equilibrium for a thin shell of general shape. State clearly the assumption made. **[7M]**

   (b) The radii of curvature of the two surfaces of semi-circular discs at the point of contact are R'1 = 60mm, R1"= 130mm, R2'= 80mm, and R2"= 200mm. The angle between the planes of minimum curvature is 60^0. Ifa load of P=4.5N is applied, determine the maximum principal stress, maximum shearing stress, and locate the point where each of these stresses occur. Also calculate the distance that the two discs move towards each other because of load P. take $E_1 = E_2 = 200$ GPa, and $_1=_2= 0.29$. **[7M]**

UNIT – III

5. (a) An industrial press is mounted on a rubber pad to isolate it from its foundation. If the rubber pad is compressed 5mm by the self-weight of the press, find the natural frequency of the system. **[7M]**

   (b) A simple pendulum is found to vibrate at a frequency of 0.5 Hz in a vacuum and 0.45Hz in a viscous fluid medium. Find the damping constant, assuming the mass of the bob of the pendulum is 1kg. **[7M]**

6. (a) A single degree of system consists of a mass of 20 kg and a spring of stiffness 4000 N/m. The amplitudes of successive cycles are found to be 50,45,40,35,... mm. Determine the nature and magnitude of the damping force and the frequency of the damped vibration. **[7M]**

   (b) A simple pendulum is set into oscillation from its rest position by giving it an angular velocity of 1rad/sec. It is found to oscillate with amplitude of 0.5 rad. Find the natural frequency and length of the pendulum. **[7M]**

UNIT – IV

7. (a) A spring mass system with viscous damping is initially at rest with zero displacement. If the system is activated by a harmonic force of frequency $\omega = \omega_n = \sqrt{k/m}$ determine the equation for its motion. **[7M]**

   (b) Determine the natural frequencies and mode shapes of the system shown in Figure 1. **[7M]**

Figure 1

8. (a) A jig used to size coal contains a screen that reciprocates with a frequency of 600cpm. The jig weighs 228 kg and has a fundamental frequency of 400 cpm. If an absorber weighing 57 kg is to be installed to eliminate the vibration of the jig frame, determine the absorber spring stiffness. What will be the resulting two natural frequencies of the system? **[7M]**

   (b) A 175 N weight is supported on several springs whose combined stiffness is 1132N/m. If the system is lifted so that the bottoms of the springs are just free and released, determine the maximum displacement of m, and the time for maximum compression. **[7M]**

UNIT – V

9. (a) Derive the equation for the natural frequencies of ta uniform cord of length L fixed at the two ends. The cord is stretched to a tension T and its mass per unit length is ρ. **[7M]**

   (b) Find the wave velocity along a rope whose mass is 0.372 kg/m when stretched to a tension of 444 N. **[7M]**

10. (a) Determine the expression for the natural frequencies of a free-free bar in lateral vibration. **[7M]**

    (b) A bat hits the baseball at its end at time t=0 with the speed of vm/s. the speed of the bat at that moment is v m/s in the direction opposite to that of the ball. Assuming that the player is holding the bat tightly at one end which is not moving, determine the natural frequency of the first mode. **[7M]**

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