Gate AE - 2009

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49) The linear system of equation Ax=b where $\mathbf{A} = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$ and $\mathbf{b} = \begin{Bmatrix} 3 \\ 3 \end{Bmatrix}$ has

a) no solution
b) infinitely many solution
c) a unique solution $x = \begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$
d) a unique solution $x = \begin{Bmatrix} 0.5 \\ 0.5 \end{Bmatrix}$

50) The correct iterative scheme for finding the square root of a positive real number R using the Newton Raphson method is

a) $x_{n+1} = \sqrt{R}$
b) $x_{n+1} = \frac{1}{2}\left(x_n + \frac{R}{x_n}\right)$
c) $x_{n+1} = \frac{1}{2}\left(\sqrt{x_n} + \sqrt{(x_{n-1})}\right)$
d) $x_{n+1} = \frac{1}{2}\left(\sqrt{R} + x_n\right)$

Common Data Question

Common Data for Question 51 and 52:
The roots of the characteristics equation for the longitudinal dynamics of a certain aircraft are : $\lambda_1 = -0.02 + 0.2i; \lambda_2 = -0.02 - 0.2i; \lambda_3 = -2.5 + 2.6i; \lambda_4 = -2.5 - 2.6i$, where $i = \sqrt{-1}$.

51) The pair of eigenvalues the represent the phugoid mode is

a) $\lambda_1 \textbf{and} \lambda_3$
b) $\lambda_2 \textbf{and} \lambda_4$
c) $\lambda_3 \textbf{and} \lambda_4$
d) $\lambda_1 \textbf{and} \lambda_2$

52) The short period damped frequency is

a) $2.6 \frac{\textbf{rad}}{\textbf{s}}$
b) $0.2 \frac{\textbf{rad}}{\textbf{s}}$
c) $2.5 \frac{\textbf{rad}}{\textbf{s}}$
d) $0.02 \frac{\textbf{rad}}{\textbf{s}}$

Common Data for Question 53 and 54 :
Consider the vector $\overrightarrow{A} = \left(y^3 + z^3\right)\hat{i} + \left(x^3 + z^3\right)\hat{j} + \left(x^3 + y^3\right)\hat{k}$ defined over the unit sphere $x^2 + y^2 + z^2 = 1$.

53) The surface integral (taken over the unit sphere) of the component of $\overrightarrow{A}$ normal to the surface is

a) π b) 1 c) 0 d) 4π

54) The magnitude of the component of $\overrightarrow{A}$ normal to the spherical surface at the point $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$ is

a) $\frac{1}{3}$ b) $\frac{2}{3}$ c) $\frac{3}{3}$ d) $\frac{4}{3}$

Common Data for Question 55 and 56:
The partial differential equation for the torsional vibration of a shaft of length L, torsional rigidity GJ, and mass polar moment of inertia per unit length I,is $I\frac{\partial^2\theta}{\partial t^2} = GJ\frac{\partial^2\theta}{\partial x^2}$, where θ is the twist.

55) If the shaft is fixed at both ends the boundary conditions are:

a) $\left.\frac{\partial\theta}{\partial x}\right|_{x=0} = 0 \text{and} \left.\frac{\partial\theta}{\partial x}\right|_{x=L} = 0$
b) $\theta(0) = 0 \text{and} \theta(L) = 0$
c) $\left.\frac{\partial\theta}{\partial x}\right|_{x=0} = 0 \text{and} \theta(L) = 0$
d) $\theta(0) = 0 \text{and} \left.\frac{\partial\theta}{\partial x}\right|_{x=L} = 0$

56) If the n^{th} mode shape of torsional vibration of the above shaft is $sin\left(\frac{n\pi x}{L}\right)$ then the n^{th} natural frequency of vibration ,i.e., ω_n, is given by

a) $\omega_n = \frac{n\pi}{L}\sqrt{\frac{GJ}{I}}$
b) $\omega_n = \frac{(2n+1)\pi}{2L}\sqrt{\frac{GJ}{I}}$
c) $\omega_n = \frac{n\pi}{2L}\sqrt{\frac{GJ}{I}}$
d) $\omega_n = \frac{(2n+1)\pi}{L}\sqrt{\frac{GJ}{I}}$

Linked Answer Question

Statement for Linked Answer Question 57 and 58:
Air enters the combustor of a gas-turbine engine at a total temperature T_0 of 500K. The air stream is split into two parts: primary and secondary streams. The primary stream reacts with fuel supplied at a fuel-air ratio of 0.05. The resulting combustion products are then mixed with the secondary air stream to obtain gas with total temperature of 1550 K at the turbine inlet. The fuel has a heating value of $42\frac{MJ}{Kg}$. The specific heats of air and combustion products are taken $c_p = 1kj/kg/k$.

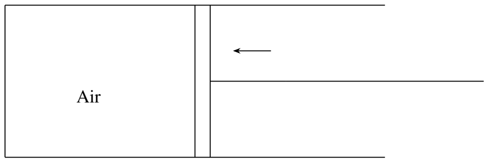
57) If the sensible enthalpy of fuel is neglected, the temperature of combustion products from the reaction of primary air stream with fuel is approximately

a) 2100K b) 3200K c) 2600k d) 1800K

58) The approximate ratio of mass flow rates of the primary air stream to the secondary air streams required to achieve the turbine inlet total temperature of 1550K is

a) 2 : 1 b) 1 : 2 c) 1 : 1.5 d) 1 : 1

Statement for Linked Answer Question 59 and 60:
A piston compresses 1 kg of air inside a cylinder as shown.



59) The rate at which the piston does work on the air is 3000W. At the same time, heat is being lost through the walls of the cylinder at a rate of 847.5W.

a) $21,525\frac{\mathbf{J}}{\mathbf{kg}}$ b) $-21,525\frac{\mathbf{J}}{\mathbf{kg}}$ c) $30,000\frac{\mathbf{J}}{\mathbf{kg}}$ d) $-8,475\frac{\mathbf{j}}{\mathbf{kg}}$

60) Given that the specific heats of air at constant pressure and volume are $c_p = 1004.5\frac{\text{J}}{\text{kg-K}}$ and $c_v = 717.7\frac{\text{J}}{\text{kg-K}}$ respectively,the corresponding changing in the temperature of the air is

a) 21.4K b) −21.4K c) 30K d) −30K