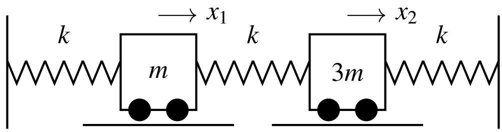
EE24BTECH11053 - S A Aravind Eswar

1) $\lim_{x \to 0} \frac{\sin x}{e^x x}$
   a) 10
   b) 0
   c) 1
   d) inf
2) Let a dynamical system be described by the differential equation $2\frac{dx}{dx} + \cos x = 0$. Which of the following differential equations describes this system in a close approximation sense for small perturbation around $x = \pi/4$?
   a) $s\frac{dx}{dt} + \sin x = 0$
   b) $2\frac{dx}{dt} - \frac{1}{\sqrt{2}}x = 0$
   c) $\frac{dx}{dt} + \cos x = 0$
   d) $\frac{dx}{dt} + x = 0$

Common Data for Questions 71, 71 & 73: An Airplane designer what to keep longitudnal static stability margin(SM) within 5% to 15% of mean aerodynamic chord. A wind tunnel test of the model showed that for $\bar{X}_C G = 0.3, \dfrac{dC_m}{dC_\perp} = 0.1$. Note that the distance from the wing leading edge to the center of gravity $(X_C G)$ has been non-dimentionalizes by dividing it with mean aerodynamic chord, $\bar{c}$, such that $\bar{X}_C G = X_C G/\bar{c}$. Note also that the relation $\dfrac{dC_m}{dC_\perp} = -SM$ holds true for this airplane.

1) The most forward location of the airplane center of gravity permitted to fulfill the designer's requirement on longitudinal static margin is
   a) $0.35\bar{c}$
   b) $0.25\bar{c}$
   c) $0.15\bar{c}$
   d) $0.52\bar{c}$
2) The most aft location of the airplane centere of the gravity permitted to fulfill designer's requirement of longitudnal static stability is
   a) $0.35\bar{c}$
   b) $0.45\bar{c}$
   c) $0.52\bar{c}$
   d) $0.67\bar{c}$
3) The center of gravity location to have $\dfrac{d\delta e}{dC_L} = 0$
   a) $0.35\bar{c}$
   b) $0.45\bar{c}$
   c) $0.5\bar{c}$
   d) $0.4\bar{c}$

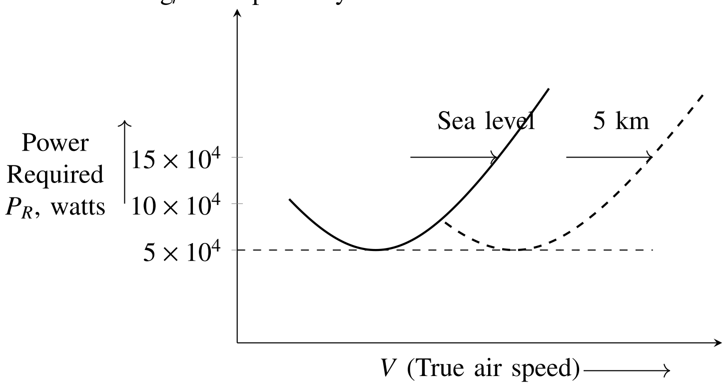
Common Data for Questions 74 & 75: Consider teh spring mass system shown in the figure below. This system has two degrees of freedom representing ther motions of the two masses.



1) The system shows the following type of coordination coupling
   a) static coupling
   b) dynamic coupling
   c) static and dynamic coupling
   d) no coupling
2) The two natural frequencies of the system are given as
   a) $\sqrt{\frac{4 \pm \sqrt{5}}{3}\frac{k}{m}}$
   b) $\sqrt{\frac{4 \pm \sqrt{3}}{3}\frac{k}{m}}$
   c) $\sqrt{\frac{4 \pm \sqrt{7}}{3}\frac{k}{m}}$
   d) $\sqrt{\frac{4 \pm \sqrt{11}}{3}\frac{k}{m}}$

Linked Answer Question: Q.76 to Q.85 carry two marks each.

Statement for Linked Answer Question 76 & 77: For a piston propeller airplane weighing 20000 N, the flight testing at 5 km pressure alitude in standard atmosphere gave the variation of power required versus true are speed as showen in the figure below. The student forgot to label the air speed axis. The maximum climb rate at sea was calculated to be 4m/s. assume shaft power available to be independent of speed of flight. For piston propellow airplane, it can be assumed that the shaft power available is propotional to ambient density. Values of air density at sea level and at 5 km pressure altitude are 1.225 kg/m^3 and 0.74 kg/m^3 respectively.



1) The maximum rate of climb achieved by this airplane at 5 km altitude will be

a) 1.65 m/s
b) 0.51 m/s
c) 1.43 m/s
d) 3.65 m/s

2) If during the maximum rate of climb at 5 km altitude, the airplane was flying at an angle of attack of 4 degrees and altitude (pitch) angle of 5 degrees, what was the equivalent airspeed of the airplane?

a) 40.2 m/s
b) 63.7 m/s
c) 130.3 m/s
d) 20.2 m/s

Statement for Linked Answer Questions 78 & 79: A modal winf rectangular platform has a chort 0.2m and a span 1.2m. It has a symmetric airfoil section whose lift curve slope is 0.1 per degree. When this wing is mounted at 8 degrees angle of attack in a freestream of 20 m/s it is found to develop 35.3N lift when the density of air 1.225 kg/m^3.

1) The lift curve slope of this wing is

a) 0.10 per deg
b) 0.092 per deg
c) 0.075 per deg
d) 0.050 per deg

2) The pan efficiency factor of this wing is

a) 1.0
b) 0.91
c) 0.75
d) 0.63

Statement for Linked Answer Question 80 & 81:

$$LetF(s) = \frac{(s+10)}{(s+2)(s+20)}$$

1) the partial fraction expression of $F(s)$

a) $\dfrac{1}{s+2} + \dfrac{1}{s+20}$
b) $\dfrac{5}{s+2} + \dfrac{2}{s+20}$
c) $\dfrac{2}{s+2} + \dfrac{20}{s+20}$
d) $\dfrac{4/9}{s+2} + \dfrac{5/9}{s+20}$

2) The inverse Laplace transform of $F(s) is$

a) $2e^{-2s} + 20e^{-20s}$
b) $\dfrac{4}{9}e^{2s} + \dfrac{5}{9}e^{-20s}$
c) $5e^{-2s} + 2e^{-20s}$
d) $\frac{9}{4}e^{-2s} + \frac{9}{5}e^{-20s}$

Statement for Linked Answer Questions 82 & 83: The equation of motion of a vibrating rod is given by $\frac{\partial^2 u}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 u}{\partial x^2}$. Here u is the displacmet along the rod and is a function of both position x and the time t. To find the response of the vibrating rod, we need to solve this equation using boundary conditions and initial conditions.

1) The Boundary conditions needed for a rod fixed at the root ($x = 0$) and free at the tip ($x = l$) are
   a) $u(x = 0) = 0, \frac{\partial u}{\partial x}(x = l) = 0$
   b) $u(x = l) = 0, \frac{\partial u}{\partial x}(x = l) = 0$
   c) $u(x = l) = 0, u(x = l) = 0$
   d) $\frac{\partial u}{\partial x}(x = 0) = 0, \frac{\partial u}{\partial x}(x = l) = 0$
2) If the polytropic efficiency of the compressor is 0.89, then the isentropic efficiency of the compressor is
   a) $\cos(\frac{\omega l}{c}) = 0$
   b) $\sin(\frac{\omega l}{c}) = 0$
   c) $\cos(\frac{\omega c}{l}) = 0$
   d) $\cos(\frac{\omega}{c}) = 0$

Statement for Linked Answer Questions 84 & 85: Air enters the compressor of a gas turbine engine with velocity 127 m/s, density 1.2 kg/m^3 and stagnation pressure 0.9 MPa. Air exits the compressor with velocity 139 m/s and stagnation pressure 3.15 MPa. Assume that the ratio of specific heats is constant and equal to 1.4.

1) The compressor pressure ratio is
   a) 0.22
   b) 0.28
   c) 3.50
   d) 3.90
2) If the polytropic efficiency of the compressor is 0.89, then the isentropic efficiency of the compressor is
   a) 0.613
   b) 0.869
   c) 0.89
   d) 0.98