Chose one of the following subjects to solve using matlab

Subject #1: heat transfer

Problem #1: the following equation is for heat conduction:

$$\frac{d^2T}{dy^2} = -\frac{\dot{q}}{k}$$

If:

q is the heat transfer in y-direction= 1000 Watt/m^3

k is the thermal conduction coefficient = 40 W/m.K

T is the temperature; in Kelvin

Write a Matlab program to solve this problem if:

1. y-range : 0 – 0.5m
2. T(0)=20 K;
3. dT/dy(0)=1 K/m.

Problem #2: Write a Matlab program to solve the following problem

A major objective in advancing gas turbine engine technologies is to increase the temperature limit associated with operation of the gas turbine blades. This limit determines the permissible turbine gas inlet temperature, which, in turn, strongly influences overall system performance. In addition to fabricating turbine blades from special, high-temperature, high-strength superalloys, it is common to use internal cooling by machining flow channels within the blades and routing air through the channels. We wish to assess the effect of such a scheme by approximating the blade as a rectangular solid in which rectangular channels are machined. The blade, which has a thermal conductivity of $k = 25$ W/m·K, is 6 mm thick, and each channel has a $2 \text{ mm} \times 6 \text{ mm}$ rectangular cross section, with a 4-mm spacing between adjoining channels.
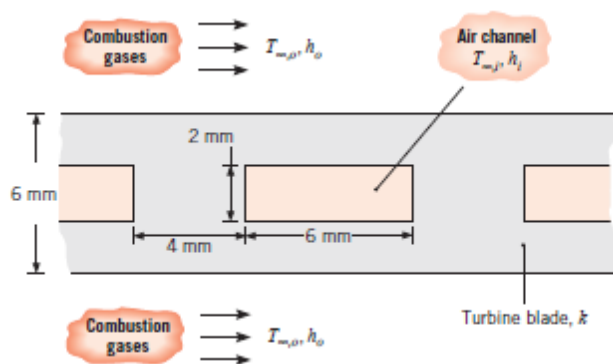
Under operating conditions for which $h_o = 1000$ W/m²·K, $T_{\infty,o} = 1700$ K, $h_i = 200$ W/m²·K, and $T_{\infty,i} = 400$ K, determine the temperature field in the turbine blade and the rate of heat transfer per unit length to the channel.

SOLUTION

Known: Dimensions and operating conditions for a gas turbine blade with embe channels.

Find: Temperature field in the blade, including a location of maximum temperature. of heat transfer per unit length to the channel.

Schematic:
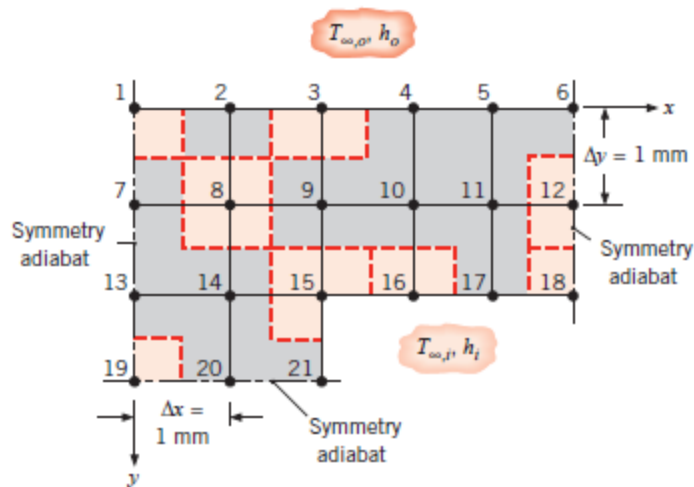
Assumptions:

1. Steady-state, two-dimensional conduction.
2. Constant properties.

Analysis: Adopting a grid space of $\Delta x = \Delta y = 1$ mm and identifying the three lines of symmetry, the foregoing nodal network is constructed. The corresponding finite-difference equations may be obtained by applying the energy balance method to nodes 1, 6, 18, 19, and 21 and by using the results of Table 4.2 for the remaining nodes.

Heat transfer to node 1 occurs by conduction from nodes 2 and 7, as well as by convection from the outer fluid. Since there is no heat transfer from the region beyond the symmetry adiabat, application of an energy balance to the one-quarter section associated with node 1 yields a finite-difference equation of the form

$$\text{Node 1:}\quad T_2 + T_7 - \left(2 + \frac{h_o \Delta x}{k}\right)T_1 = -\frac{h_o \Delta x}{k}T_{\infty,o}$$

A similar result may be obtained for nodal region 6, which is characterized by equivalent surface conditions (2 conduction, 1 convection, 1 adiabatic). Nodes 2 to 5 correspond to case 3 of Table 4.2, and choosing node 3 as an example, it follows that

$$\text{Node 3:}\quad T_2 + T_4 + 2T_9 - 2\left(\frac{h_o \Delta x}{k} + 2\right)T_3 = -\frac{2h_o \Delta x}{k}T_{\infty,o}$$

Nodes 7, 12, 13, and 20 correspond to case 5 of Table 4.2, with $q'' = 0$, and choosing node 12 as an example, it follows that

$$\text{Node 12:}\quad T_6 + 2T_{11} + T_{18} - 4T_{12} = 0$$

Nodes 8 to 11 and 14 are interior nodes (case 1), in which case the finite-difference equation for node 8 is

$$\text{Node 8:}\quad T_2 + T_7 + T_9 + T_{14} - 4T_8 = 0$$

Node 15 is an internal corner (case 2) for which

$$\text{Node 15:}\quad 2T_9 + 2T_{14} + T_{16} + T_{21} - 2\left(3 + \frac{h_i \Delta x}{k}\right)T_{15} = -2\frac{h_i \Delta x}{k}T_{\infty,i}$$

while nodes 16 and 17 are situated on a plane surface with convection (case 3):

$$\text{Node 16:}\quad 2T_{10} + T_{15} + T_{17} - 2\left(\frac{h_i \Delta x}{k} + 2\right)T_{16} = -\frac{2h_i \Delta x}{k}T_{\infty,i}$$

In each case, heat transfer to nodal regions 18 and 21 is characterized by conduction from two adjoining nodes and convection from the internal flow, with no heat transfer occurring from an adjoining adiabat. Performing an energy balance for nodal region 18, it follows that

$$\text{Node 18:} \quad T_{12} + T_{17} - \left(2 + \frac{h_i \Delta x}{k}\right) T_{18} = -\frac{h_i \Delta x}{k} T_{\infty,i}$$
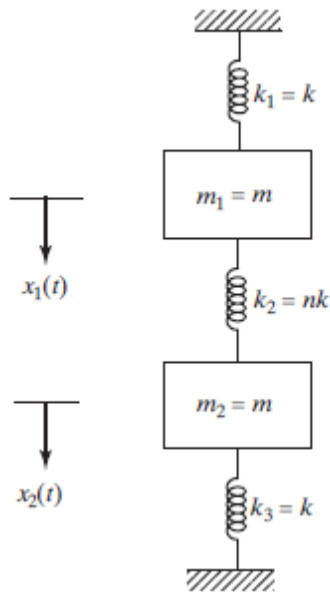
The last special case corresponds to nodal region 19, which has two adiabatic surfaces and experiences heat transfer by conduction across the other two surfaces.

$$\text{Node 19:} \quad T_{13} + T_{20} - 2T_{19} = 0$$

Subject #2: mechanical vibrations and strength of materials

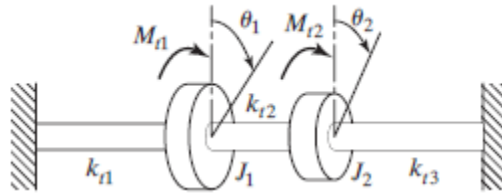**Problem#3:** for the following 2-degree of freedom vibration system shown in the figure

The governing equations are:

$$m\ddot{x}_1 + 2kx_1 - kx_2 = 0$$
$$m\ddot{x}_2 - kx_1 + 2kx_2 = 0$$

Write a Matlab program to find x_1 and x_2 if:

1. m=1 kg
2. k=1000N/m
3. $x_1(0)=x_2(0)=0$
4. $dx_1/dt(0)=0$ & $dx_2/dt(0)=0$

Problem#4: for the following 2-degree of freedom vibration system shown in the figure

The governing equations are:

$$J_1\ddot{\theta}_1 + (k_{t1} + k_{t2})\theta_1 - k_{t2}\theta_2 = M_{t1}$$

$$J_2\ddot{\theta}_2 - k_{t2}\theta_1 + (k_{t2} + k_{t3})\theta_2 = M_{t2}$$

Write a Matlab program to find x_1 and x_2 if:

$$k_{t1} = \frac{GI_{01}}{l_1} = \frac{G}{l_1}\left(\frac{\pi d_1^4}{32}\right) = \frac{(80 \times 10^9)(\pi)(0.10)^4}{(0.8)(32)} = 981{,}750.0 \text{ N-m/rad}$$

$$k_{t2} = \frac{GI_{02}}{l_2} = \frac{G}{l_2}\left(\frac{\pi d_2^4}{32}\right) = \frac{(80 \times 10^9)(\pi)(0.15)^4}{(1.0)(32)} = 3{,}976{,}087.5 \text{ N-m/rad}$$
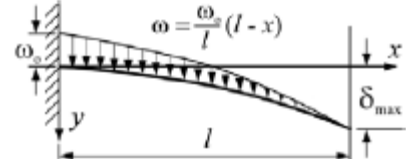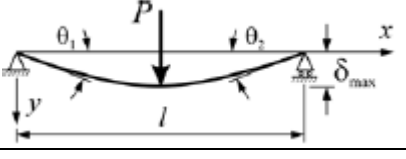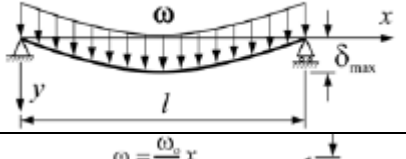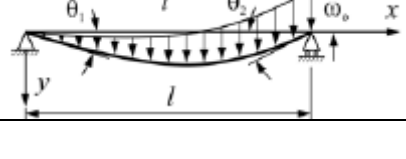
$M_{t1} = M_{t2} = 2\text{kN.m}$
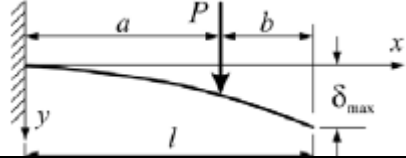
$J_1 = J_2 = 600\text{kg-m}^2$

Problem #5: for the damped system described by the following equation
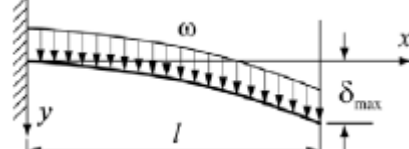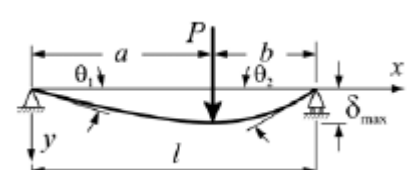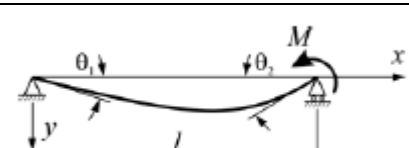
$$m\ddot{x} + c\dot{x} + kx = F_0 \cos \omega t$$

Solve to find x(t) using Matlab. Assume zero I.Cs

Problem #6: the following are beam deflection equations. Draw the beam deflection curve using matlab for a chosen beam from your own selection.

| Case	System description	DEFLECTION AT ANY SECTION IN TERMS OF x
1		$y = \dfrac{Px^2}{6EI}(3a-x)$ for $0<x<a$ $y = \dfrac{Pa^2}{6EI}(3x-a)$ for $a<x<l$
2		$y = \dfrac{\omega_o x^2}{120 l EI}\left(10l^3 - 10l^2 x + 5lx^2 - x^3\right)$
3		$y = \dfrac{Px}{12EI}\left(\dfrac{3l^2}{4} - x^2\right)$ for $0<x<\dfrac{l}{2}$
4		$y = \dfrac{\omega x}{24EI}\left(l^3 - 2lx^2 + x^3\right)$
5		$y = \dfrac{\omega_o x}{360 l EI}\left(7l^4 - 10l^2 x^2 + 3x^4\right)$

Problem #7: the following are beam deflection equations. Draw the beam deflection curve using matlab for a chosen beam from your own selection.

Case	System description	DEFLECTION AT ANY SECTION IN TERMS OF x
1		$$y = \frac{Px^2}{6EI}(3l - x)$$
2		$$y = \frac{\omega x^2}{24EI}\left(x^2 + 6l^2 - 4lx\right)$$
3		$$y = \frac{Mx^2}{2EI}$$
4		$$y = \frac{Pbx}{6lEI}\left(l^2 - x^2 - b^2\right) \text{ for } 0 < x < a$$ $$y = \frac{Pb}{6lEI}\left[\frac{l}{b}(x-a)^3 + \left(l^2 - b^2\right)x - x^3\right]$$ $$\text{for } a < x < l$$
5		$$y = \frac{Mlx}{6EI}\left(1 - \frac{x^2}{l^2}\right)$$

Subject #3: automatic control system

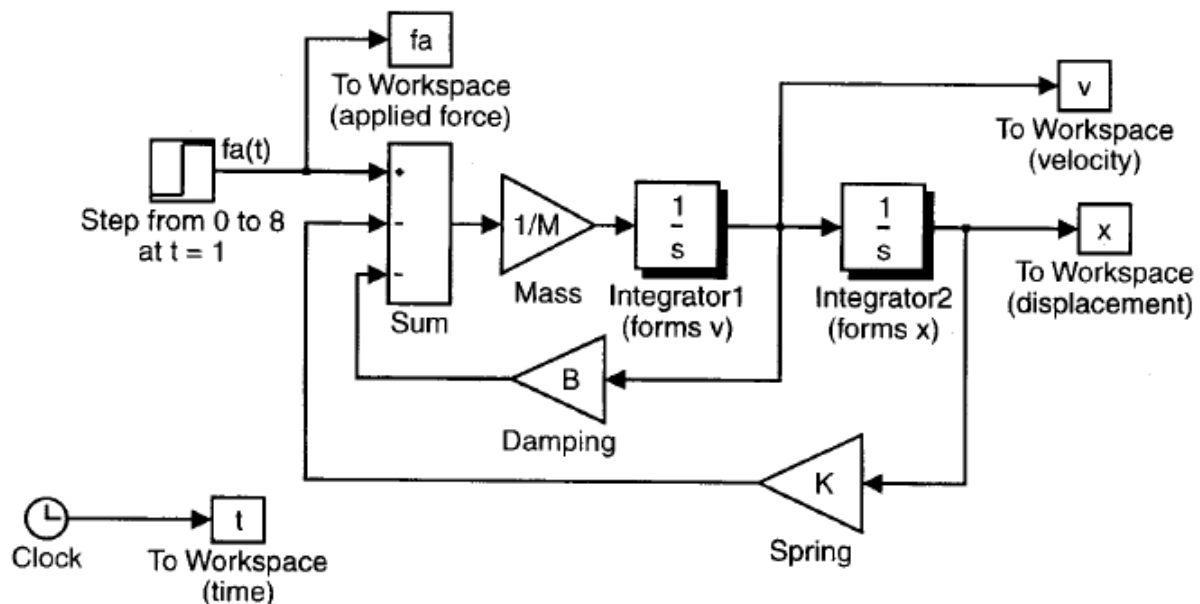**Problem#8:** use matlab simulink to simulate the following control system(find v(t))
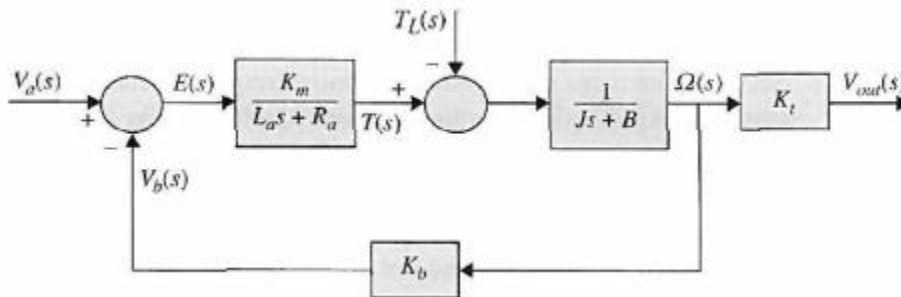
Assume

La=0.003   Ra=5   Km=1   T$_L$=0   J=0.0002   B$_t$=0.015   Kt=2   Kb=0.5

Also assume step input: v$_{in}$ = 5volt

Problem#9: the following simulink diagram is used to simulate a vibrating system

Redraw this system and find the response x and v if : input force that increases from 0 to 8 N at t=1 s. The parameter values are M = 2kg, K= 16N/m and B=4N.s/m

Subject #4:numerical methods

Problem #10: write a matlab m-file to find the roots of the following equations using:
1. bisection method
2. false position method

the equations are:
1. $f(x) = 5x^3 - 5x^2 + 6x - 2$
2. $f(x) = \sin(x^2) + \cos(x)$ for $0 < x < \pi$

Problem #11: write a matlab m-file to find the following integrations numerically using Simpson's 3/8 rule. use 5 iterations

$$\int_{-2}^{4} \left(\frac{1x - 4x^3}{\ln(x+1)} \right) dx$$

Problem #12: find the solution for the following equations using matlab ode45 code where y=f(t)

$$\frac{dy}{dt} = \sin(50t) - 2t^2 + 5$$
$$5y'' + 3y' + 1 = 0$$
$$t^2 y + y'' = 10$$