MEE20007 Design and Product Visualization Project

MATLAB/SIMULINK

ASSIGNMENT SEMESTER 1 – 2023

Instructions:

*1. Submit your files on the CANVAS portal **"MS_ASSIGNMENT 2023"** by 11:59 PM on Friday 5th April 2023. Please refer to **MEE20007 Unit Outline,** under section B for "Submission Requirements" and "Extensions and Late Submissions".*

2. The assignment must be solved in the appropriate software. With the submitted electronic answers comprising a fully commented script detailing your workings where applicable, which indicates how you have solved the problem and script functionality. If any external working has been done please include them within the final submission. These may scanned if handwritten. Without showing your working, you cannot expect full marks.

3. It should be clear that every student will work out his/her own solutions and completely abstain from copying someone else's work. Please refer to MEE20007 Unit Outline, under section C for "Plagiarism".

Q.1. A plane truss is loaded and while solving for internal forces in truss members we are able to formulate the ten equations given below:

Ax +AD =0; Ay +AB =0; 74+ BC+(3/5) BD =0; -AB – (4/5) BD = 0;

-BC +(3/5) CE = 0; -24 –CD- (4/5) CE =0; -AD+DE-(3/5) BD = 0;

CD + (4/5) BD =0; -DE –(3/5) CE =0; E_y + (4/5) CE =0;

Ax , Ay and Ey are support reactions, while the letters BC, CD etc. represent the internal forces in corresponding truss members. Solve for all unknown forces using **MATLAB**.

Hint: Solve by the matrix method for simultaneous linear equations

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Q.2. With the help of **MATLAB** determine the magnitude and the instant of peak value for the variable 'z' using the following equation:

$$z = z_0 + \frac{m}{c} * \left(v_0 + \frac{m.g}{c}\right)\left(1 - e^{-(^c/_m)t}\right) - \frac{m.g}{t}$$

For this problem use the following parameters: z_0 =100 m, v_0 =60 m/s, m = 2 kg and c =15 kg/s. The time vector ranges from 0 to 15 seconds.

Plot **z vs t** and use **'fprintf'** to print the peak value of 'z' on screen.

Q.3. The altitude (height) of a weather balloon (in metres) during first 60 hours after the launch is given by the polynomial: $h(t) = -0.12\,t^4 + 12\,t^3 - 380t^2 + 4100t + 220$. where ‘t’ is in hours. Find the expressions for velocity and acceleration in terms of time using the ‘derivative’ and ‘integral’ blocks in **Simulink**. P**lot ‘height, velocity and acceleration vs. time’** for 48 hours of flight in the same scope. Provide appropriate title and legends.

Q.4. The acceleration of a vehicle is given in the form of following differential equation: $565\frac{dv}{dt} = 1000 - 24v$. Values are in MKS units. Develop a model in Simulink that can plot the velocity for first 5 minutes of motion while starting from rest. Find out the steady state velocity in *km/hr* and the time to attain that velocity.

Q.5. The heat capacity of a gas can be modelled with the equation: $C_p = a + bT + cT^2 + dT^3$, where a,b,and c are empirical constants and T is temperature in kelvins. The change in enthalpy of gas when it is heated from T_1 to T_2 is given by the following integral: $\Delta h = \int_{T_1}^{T_2} C_p\, dT$. Write a MATLAB script to:

(a) create a table to show the changes in value of enthalpy of oxygen gas at intervals of 100 K as it is heated from 400 K to 1100 K.

(b) plot the change in value of C_p with respect to temperature in the same range. Make your plot more readable and presentable as possible.

For oxygen empirical constants are given as: a=25.48, b= 1.52×10^{-3} , c= -0.7155×10^{-5} and d= 1.312×10^{-9}.

Q.6. Consider the following two equations:

$$x^2 + y^2 = 42 \text{---------------- (1)}$$

$$x^4 + 3\,y - 2\,y^2 = 6 \text{-------------------- (2)}$$

(a) Find the solution to these equations graphically by plotting in Matlab while selecting a suitable data range. *Hint: Choose a range of values for ‘x’ and plot the graph of y(1) and y(2) vs x.*

(b) For the symbolic expressions from Left hand side of each equation, find out their differential (derivative) and integral with respect to ‘x’ and ‘y’ using Matlab’s symbolic math capability.

Q.7. Roller bearings are subjected to fatigue failure caused by large contact loads. The location of maximum stress along the x-axis is equivalent to finding the maximum value of force function: $F(x) = \frac{0.4}{\sqrt{1+x^2}} - \sqrt{1+x^2} * \left(1 - \frac{0.4}{1+x^2}\right) + x$. Using Simulink plot F(x) vs x and find graphically the value of $'x'$ that maximizes F(x). Note that the value of 'x' varies from 0 to 1.5. *Hint: Use a Ramp input for 'x' with simulation stop time = 1.5*

Q.8. A homogenous beam is freely hinged at its ends *x* =0 and *x* =*L*, so that the ends are at the same level. It carries a uniformly distributed load of intensity *W* per unit length, and there is a tension *T* along the *x*-axis. At any x the deflection *y* of the beam as measured from left end is given by

$$y = \frac{WEI}{T^2} \cdot \left[\frac{\cosh\left[a\left(\frac{L}{2} - x\right)\right]}{\cosh\left(\frac{aL}{2}\right)} - 1 \right] + \frac{Wx(L-x)}{2T}$$

where $a^2 = T/EI$, *E* being the Young's modulus of the beam, and *I* is the moment of inertia of cross-section of the beam. The beam is 10m long, the tension is 1.1kN, the load 200 N/m, and *EI* is 12450 N.m^2. Write a script in MATLAB to compute and plot a graph of the deflection *y* against *x*. (*Note: MATLAB has a* ***cosh*** *function). To make the graph more realistic you should override MATLAB's automatic axis scaling with the statement* ***axis([xmin xmax ymin ymax])*** *after the plot statement.*

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