ME4120: Modeling and Simulation

ASSIGNMENT-2 and Project Details (Date: 05/03/2018)

Maximum Marks: 100 Due date: 19/3/2018

1. Define initial value problem (IVP) and boundary value problem (BVP) with appropriate boundary conditions. Also name atleast two methods for solving IVP and BVP.

2. To solve a system of ordinary differential equations, first describe Taylor series in general and write required the input and script files for solving equation $y' + 4y = x^2;\ y(0) = 1$ using Taylor's method upto fourth order.

3. Derive the formula of modified Euler's method. Obtain the range of step size to maintain the stability of the solver. Also, write the function file for modified Euler method. How to handle the stability of these methods to tackle stiff problems.

4. Using finite difference method, solve linear ordinary differential equation $y'' = -4y + 4x, y(0) = 0, y'(\pi/2) = 0$ with n=3. Subsequently, write a function file to generalize it for n=10; Also, write the final script file to execute the solution of above equation using finite difference method.

5. Describe shooting method to solve equation $y'' = 9y + 18x - 9, y(0) = 1,\ y(1) = -1.$ Write the function file for the above problem and other files for executing shooting method.

6. Define the ill-conditioning of a system of linear equations and dicuss mechanisms to deal with ill-conditioning.

7. List the direct and indirect methods to solve the system of linear equations.
   Write the function file for Gauss elimination method and then solve the following equations

   (a) $A = \begin{bmatrix} 3 & -3 & 3 \\ -3 & 5 & 1 \\ 3 & 1 & 5 \end{bmatrix}, b = \begin{bmatrix} 9 \\ -7 \\ 12 \end{bmatrix}$ (b) $\begin{matrix} 4x_1 - x_2 = 9 \\ -x_{i-1} + 4x_i - x_{i+1} = 5,\ i = 2, \dots, n-1, \\ -x_{n-1} + 4x_n = 5 \end{matrix}$

   where, n=10 and 20.

8. After describing Gauss-Seidel method and Conjugate Gradiant method, solve the above equations in (9) using these methods with the help of Matlab. Subsequently, comment on the rate of convergence of both the methods.

9. Differentiate between two different ways of developing APPs using MATLAB and also mention their limitation.

10. Using any of the above methods, develop apps for the following problem:
    (a) Transient heat conduction
    (b) Inviscid channel flow
    (c) Potential flow
    (d) Boundary layer flow over a plate

    Take help from the webinar https://in.mathworks.com/videos/teaching-fluid-mechanics-and-heat-transfer-with-interactive-matlab-apps-81962.html .

11. Please develop a simple GUI model for the following model:
    a) Group A (ME15BTech11005; ME15BTech11008; ME15BTech11009; ME15BTech11015):
    Title: Energy based simulation of a Timoshenko beam in non-forced rotation
    https://hal.archives-ouvertes.fr/file/index/docid/918635/filename/Hammer.pdf
    b) Group B (ME15BTech11040; ME15BTech11034; ME15BTech11023; ME15BTech11026):
    Title: Modeling and simulation of automobile braking system
    http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4677741
    c) Group C (ME15BTech11030; ME15BTech11039; ME15BTech11041; ME15BTech11035):
    Title: Modeling and simulation of anti-lock braking system
    https://in.mathworks.com/help/simulink/examples/modeling-an-anti-lock-braking-system.html
    d) Group D (ME15BTech11037; ME15BTech11014; ME15BTech11011; ME15BTech11021):
    Title: Modeling and simulation of electric and hybrid vehicles
    https://www.researchgate.net/profile/Chris_Mi/publication/2998232_Modeling_and_Simulation_of_Electric_and_Hybrid_Vehicles/links/0c960518a7a752f2ab000000.pdf
    e) Group E (ME15BTech11016; ME15BTech11004; ME15BTech11020; ME15BTech11038):
    Title: Dynamic modeling and control of hybrid electric vehicle power train
    http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=722250
    f) Group F (ME15BTech11003; ME15BTech11007; ME15BTech11036; ME15BTech11042):
    Title: Simulation of impingement and spreading of micro-droplet on non-homogeneous solid surface. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6559750

g) Group G (ME15BTech11029; ME15BTech11019; ME15BTech11028; ME15BTech11032):
Title: Modeling and simulation of vibration of a tractor gearbox.
http://ir.jkuat.ac.ke/bitstream/handle/123456789/733/Kimotho%2CJ.Kuria_Msc.Mechanical%20Engineering.pdf?sequence=1&isAllowed=y

h) Group H (ME15BTech11006; ME15BTech11031; ME15BTech11002; ME15BTech11027):
Title: Modeling and simulation of a flexible inverted pendulum system
http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6075558

i) Group I (ME15BTech11022; ME14BTech11019; ME15BTech11033; ME15BTech11013):
Title: Computer simulation of internal combustion engine https://repositorio-aberto.up.pt/bitstream/10216/60145/1/000129268.pdf

j) Group J (ME15BTech11010; ME15BTech11025; ME15BTech11024; ME15BTech11018):
Title: Modeling and nonlinear control of a flexible link manipulator/ a flexible robot arm
https://ac.els-cdn.com/S0307904X13003107/1-s2.0-S0307904X13003107-main.pdf?_tid=880817d5-aac2-4402-bcd6-b6894a9c0e41&acdnat=1520243301_d23de11a924f2d9472e9132aa156da39 ;
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=559022