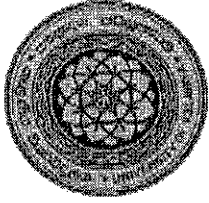


Supervisor's Signature:.....

Date:11.07.2026



UNIVERSITY OF KELANIYA - SRI LANKA
Centre for Distance & Continuing Education
Bachelor of Science (General) Degree External
Second Year Second Semester Examination – 2021
(New Syllabus)
2026 July
Faculty of Science

Index Number:.....

Course Code:..... AMAT 27582

Course Title:... Scientific Computing using Appropriate
Software II

Date:... 11/07/2026

QUESTION	MARKS, %	
	First Examiner %	Second Examiner %
1		
2		
3		
4		
5		
TOTAL		

First Examiner's Marks, %	
Second Examiner's Marks, %	
Total (200)	
Average	

APPLIED MATHEMATICS

AMAT 27582 – Scientific Computing using Appropriate Software II

No. of Questions: Five (05)

No. of Pages: Eleven (11)

Time Allowed: Two (2) hrs

Answer Four (04) Questions Only

Instructions to candidates

Programmable Calculators Are Not Allowed

Answer only **Four (04)** Questions.

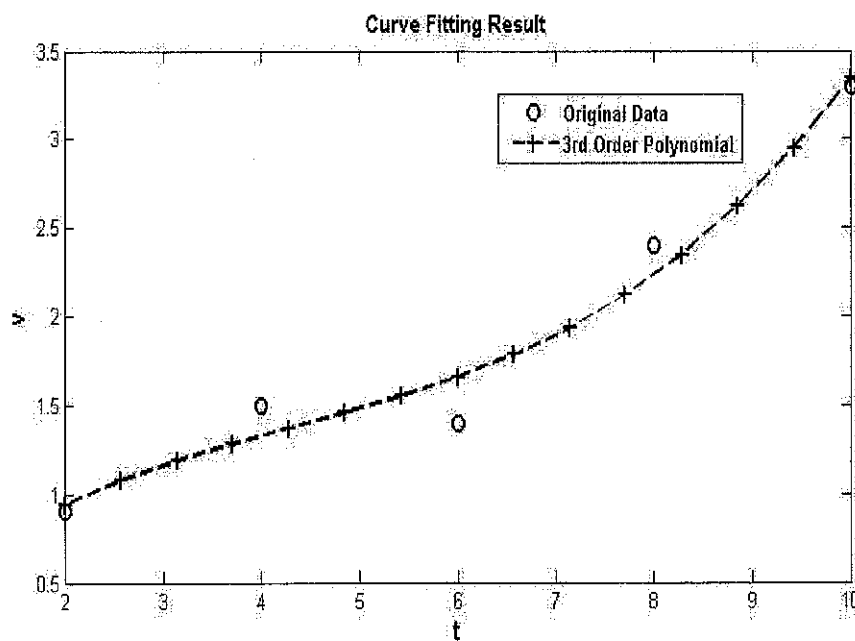
All questions are to be **answered in the boxes** provided within this booklet.

You are **not allowed** to remove any page from this booklet.

1. (a) Write an M-file that fits the data given in the table below with a third-degree polynomial using `polifit()` and `polyval()`. Your M-file should also generate the graph shown below.

[50 marks]

t	2	4	6	8	10
$v(t)$	0.9	1.5	1.4	2.4	3.3



Continued...

(b) The function file given below uses Naive Gauss Elimination to solve linear systems.

Fill in the answer boxes with a single line of MATLAB code.

[50 marks]

% Function declaration below

% Function name : GaussNaive

% Gauss elimination without pivoting.

% input:

% A = coefficient matrix

% b = right hand side vector

% output:

% x = solution vector

[m,n] = size(A);

% Non-square A, exit with error()

if m~=n, error('Matrix A must be square'); end

nb = n+1; % Column index of b values in Aug

Aug =

% create the augmented matrix

Continued...

% forward elimination

% Looping through columns in Aug

for k =

for i = k+1:n % Looping through rows r below current pivot

factor = Aug(i,k)/Aug(k,k);

Aug(i,k:nb) = Aug(i,k:nb)-factor*Aug(k,k:nb);

end

disp(Aug);

% back substitution

% pre-allocating x vector

x=

% Calculating last x value

x(n) = Aug(n,nb)/Aug(n,n);

% Moving through x values backward

for i=

x(i) = (Aug(i,nb)-Aug(i,i+1:n)*x(i+1:n))/Aug(i,i);

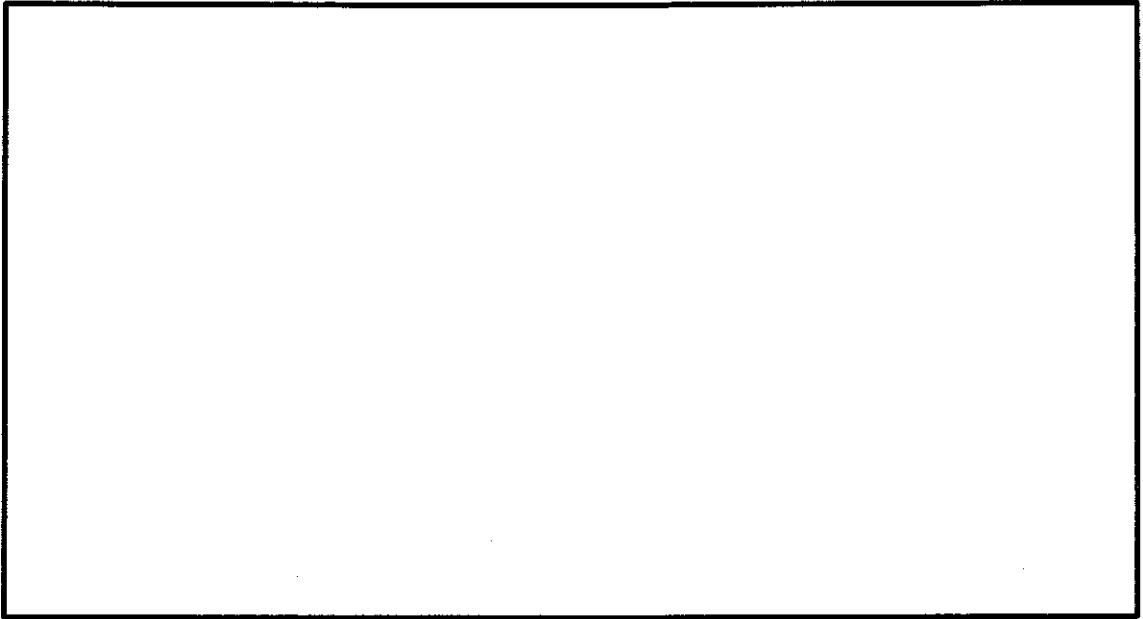
end

2. Consider the following ordinary differential equation:

$$\frac{dy}{dt} = 1.8 y t^2 - 1.3 y$$

- (a) Use Euler's method to integrate $\frac{dy}{dt}$ from $t = 0$ to $t = 1.5$ with a step size of 0.5. The initial condition is $y(0) = 1$. Show your workings for each iteration. [15 marks]

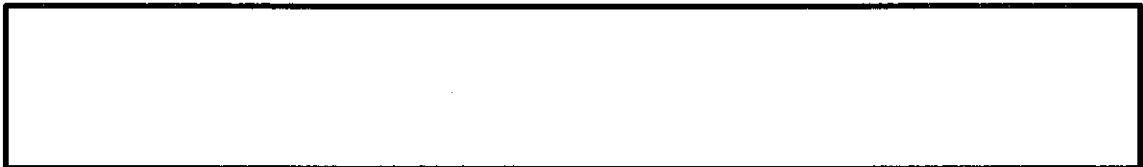
Continued...



- (b) Explain the way of using MATLAB built-in function `ode45` to integrate $\frac{dy}{dt}$ from $t = 0$ to $t = 1.5$ with $y(0) = 1$. [40 marks]

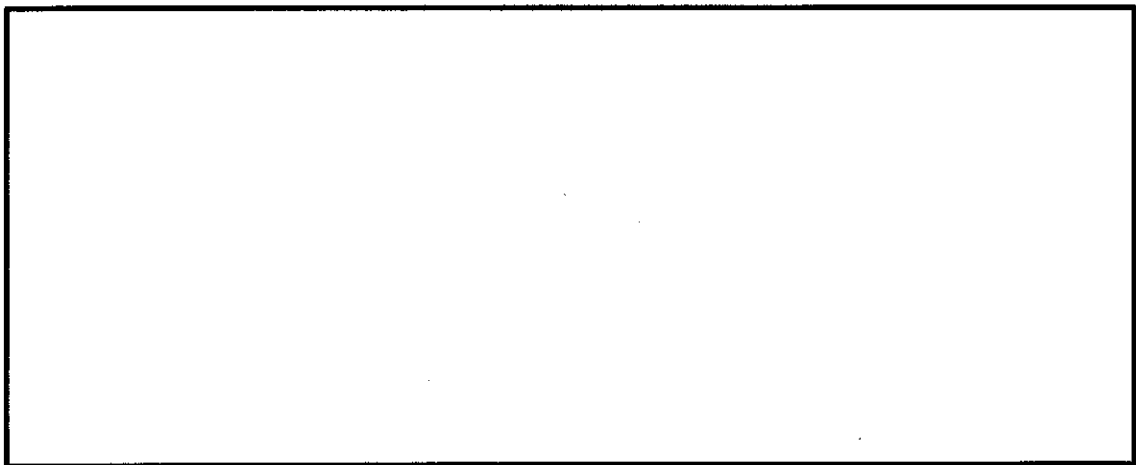
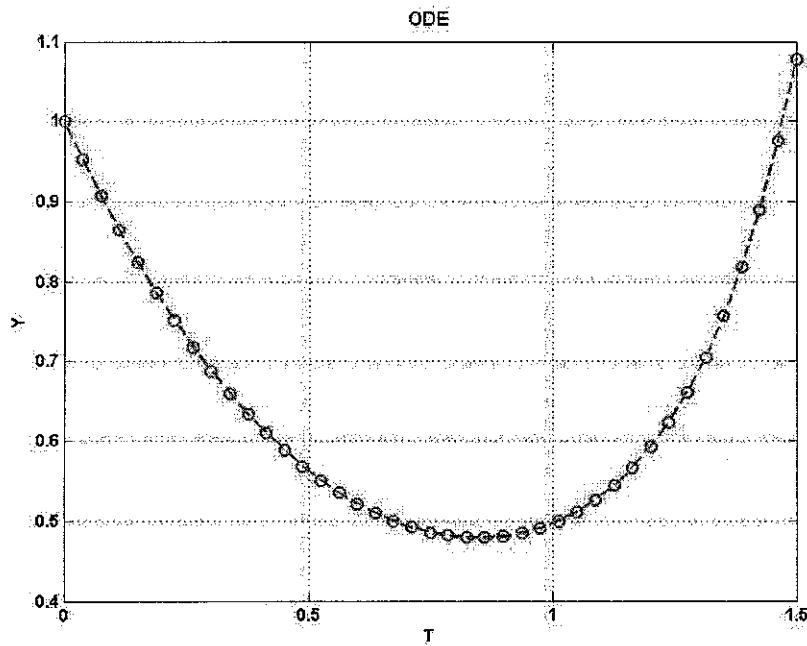
The `ode45` help is as follows.

ODE45 Solve non-stiff differential equations, medium order method.
[TOUT,YOUT] = ODE45(ODEFUN,TSPAN,Y0) with TSPAN = [T0 TFINAL] integrates the system of differential equations $y' = f(t,y)$ from time T0 to TFINAL with initial conditions Y0. ODEFUN is a function handle. For a scalar T and a vector Y, ODEFUN(T,Y) must return a column vector corresponding to $f(t,y)$. Each row in the solution array YOUT corresponds to a time returned in the column vector TOUT. To obtain solutions at specific times T0,T1,...,TFINAL (all increasing or all decreasing), use TSPAN = [T0 T1 ... TFINAL].



- (c) Write a M-file to generate the following figure. The code should make sure that the limits of the horizontal axis are adjusted to [0, 1.5], and the limits of the vertical axis are adjusted to [0.4, 1.1]. [45 marks]

Continued...



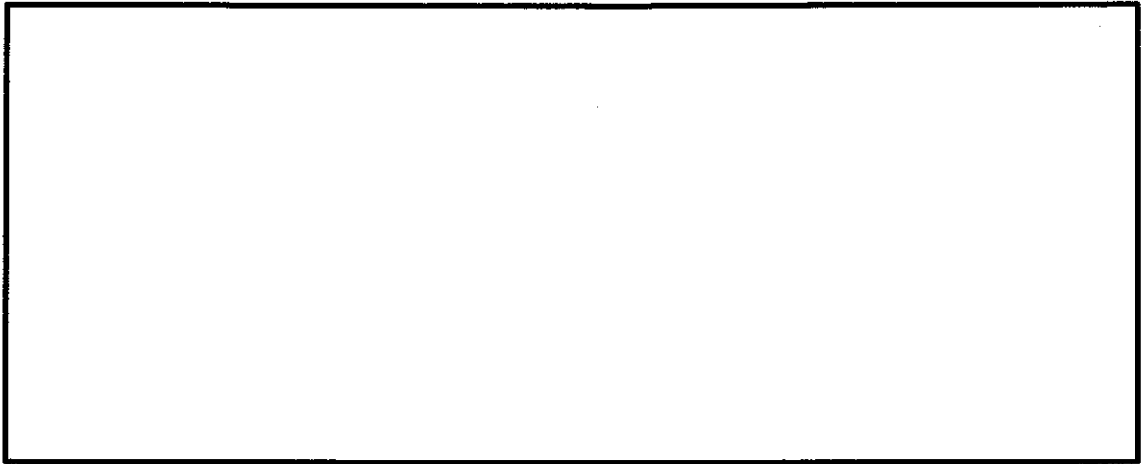
3. It is proposed to use **ode45** to solve the system of ordinary differential equations

$$\frac{dy_1}{dt} = 1 - y_1 y_2, \quad \frac{dy_2}{dt} = (y_1 - y_2) y_1 - y_2.$$

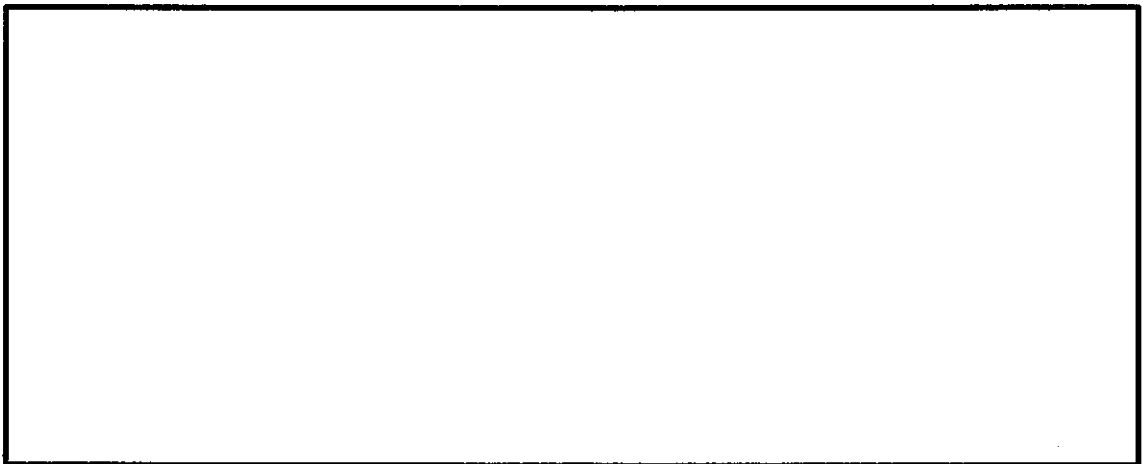
A solution is required for time t running from 0 to 15 seconds. The initial values at $t = 0$ are $y_1(0) = 0$ and $y_2(0) = 1$.

- (a) Explain the way of using **ode45** to obtain an approximate solution to the equations. [50 marks]

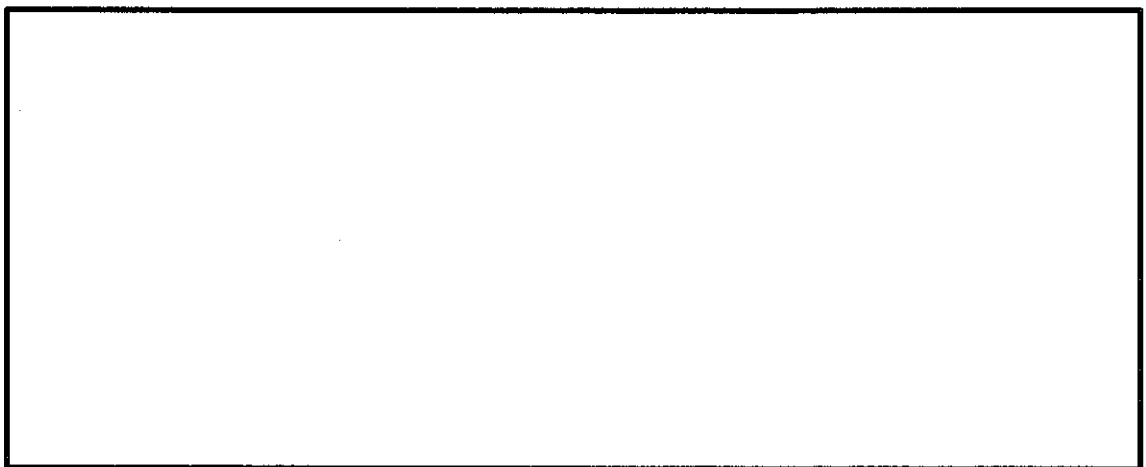
Continued...



- (b) What commands are required to obtain a time plot of both y_1 and y_2 ? Axis labels and a legend identifying the curves y_1 and y_2 are required. **[20 marks]**



- (c) What commands are required to produce a state-space or phase plot of y_2 against y_1 without overwriting the first plot? **[30 marks]**



Continued...

4. (a) The following function file is supposed to determine the slope (a_1), the intercept (a_2) and the coefficient of determination r^2 in the process of least square curve fitting technique.

```
1 function [a, r2] = linregr(x,y)
2 % [a, r2] = linregr(x,y):
3 %   Least squares fit of a straight line to data
4 %   by solving the normal equations.
5 % input:
6 %   x = independent variable
7 %   y = dependent variable
8 % output:
9 %   a = vector of slope, a(1), and intercept, a(2)
10 %   r2 = coefficient of determination
11
12 n = length(x);
13 if length(y)~=n, error(x and y must be same length); end
14 x = x(:); y = y(:); % convert to column vectors
15 sx = sum(x); sy = sum(y);
16 sx2 = sum(x.*x); sxy = sum(x*y); sy2 = sum(y.*y);
17 a(1) = (n*sxy-sx*sy)/(n*sx2-sx^2);
18 a(2) = sy/n-a(1)*sx/n;
19 r2 = ((n*sxy-sx*sy)/sqrt(n*sx2-sx^2)/sqrt(n*sy2-sy^2))^2;
20 % create plot of data and best fit line
21 xp = linspace(min{x},max(x),2);
22 yp = a(1)*xp+a(2);
23 plot(x,y,'o',xp,yp)
24 grid on
```

When attempting to run the code by typing `>> [a, r2] = linregr(x,y)` in the command window, MATLAB returns the following error message.

Error: File: linregr.m Line: 13 Column: 26
Unexpected MATLAB expression.

- (i) Considering the error message above, indicate the line number(s) of the code that is wrong and fix the problem. [10 marks]

Continued...

After fixing the previous syntax error, attempt to run the code again and MATLAB return the following error message.

```
Error using *  
Inner matrix dimensions must agree.
```

```
Error in linregr (line 16)  
sx2 = sum(x.*x); sxy = sum(x*y); sy2 = sum(y.*y);
```

- (ii) Considering the error message above, describe the error message with the line number(s) and fix the problem. [15 marks]

After fixing the previous syntax error, attempt to run the code a third time and MATLAB return the following error message.

```
Undefined variable min.
```

```
Error in linregr (line 21)  
xp = linspace(min{x},max(x),2);
```

- (iii) Consider the error message above, describe what the command `linspace` does.
Why has the error message occurred?
How would you rewrite the code to fix the problem? [15 marks]

Continued...

(b) Suppose that the following commands are written in the MATLAB command window.

```
t=linspace(0, 3*pi, 50);  
x=sin(t) + cos(pi*t);  
y=tan(t/3);
```

- (i) Write a single-line MATLAB command to plot both x and y as functions of t on the same graph. The graph for x should be a red dotted curve with asterisk markers, and the graph for y should be a black dashed curve with circle markers. [30 marks]

- (ii) Write proper commands to add the title, axis labels and legends with the location 'northwest' of the figure. [30 marks]

5. Consider the following ordinary differential equation:

$$\frac{dy}{dt} = 4e^t - \frac{y}{3}$$

- (a) Use Euler's method to integrate $\frac{dy}{dt}$ from $t = 0$ to $t = 3$ with a step size of 1. The initial condition is $y(0) = 3$. Show your workings for each iteration. [30 marks]

Continued...

- (b) Use Heun's method to integrate $\frac{dy}{dt}$ from $t = 0$ to $t = 3$ with a step size of 1. The initial condition is $y(0) = 3$. Show your workings for each iteration.

In the usual notation, the formula for the Heun's method are as follows.

$$y_{i+1}^0 = y_i + f(t_i, y_i)h, \quad y_{i+1} = y_i + \frac{f(t_i, y_i) + f(t_{i+1}, y_{i+1}^0)}{2} h \quad [35 \text{ marks}]$$

- (c) Which method above produces a better approximation of $y(3)$. Give reasons. [10 marks]

- (d) Explain the way of using MATLAB built-in function **ode45** to integrate $\frac{dy}{dt}$ from $t = 0$ to $t = 3$ with $y(0) = 3$. [25 marks]

-----⊗ End of the Examination Paper ⊗-----

10