ECE 811 – SOFTWARE ENGINEERING

INTRODUCTION TO MATLAB FOR ELECTRICAL ENGINEERS- TEST YOUR KNOWLEDGE

BASIC OPERATIONS

1. How do you define a complex number 3+4j in MATLAB?

   A: `z = 3 + 4i; or z = complex(3, 4);`

2. Write code to create a 5×5 identity matrix.

   A: `I = eye(5);`

3. What is the output of A = [1, 2; 3, 4]; B = [5; 6]; x = A\B?

   A: `x = [-4; 4.5] (solution to Ax=B).`

4. Write code to compute the inverse of matrix $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$

   A:
   ```
   A_inv = inv(A);
   ```

5. How do you solve 2x+3y=5 and 4x+y=3?

   A: Write code as follows:

   ```
   A = [2, 3; 4, 1];
   B = [5; 3];
   sol = A\B;
   ```

6. Write MATLAB code to plot a sine wave (50 Hz, amplitude 1) for 2 seconds (sampling rate: 1 kHz).

   A: MATLAB code is as shown below:

   ```
   t = 0:0.001:2;
   y = sin(2*pi*50*t);
   plot(t, y);
   ```

7. How do you create a Bode plot for $H(s) = \frac{1}{s^2+0.5s+1}$?

   A: The MATLAB code for the Bode plot is:

   ```
   sys = tf(1, [1, 0.5, 1]);
   bode(sys);
   ```

8. Write MATLAB code to generate a Nyquist plot for the system $H(s) = \frac{1}{s+1}$

   A: The MATLAB code to generate a Nyquist plot is:

   ```
   sys = tf(1, [1, 1]);
   nyquist(sys);
   ```

9. Write a MATLAB code to two signals (sin(t) and exp(t) on the same graph with different y-axes.

A: The MATLAB code to plot two signals on the same graph with different axes is:

```
yyaxis left; plot(t, sin(t));
yyaxis right; plot(t, exp(t));
```

10. Create a 3D surface plot of z=sin(x)cos(y) for x,y∈[−π,π].

A: The MATLAB code to create 3D surface plot is:

```
[X,Y] = meshgrid(-pi:0.1:pi);
Z = sin(X).*cos(Y);
surf(X,Y,Z);
```

11. Compute the FFT of a signal x=cos(2π·100·t) (1 kHz sampling, 1-second duration).

A: The MATLAB code to compute the FFT is:

```
t = 0:0.001:1-0.001;
x = cos(2*pi*100*t);
X = fft(x);
f = (0:999)*1000/1000;
plot(f, abs(X));
```

12. Generate white Gaussian noise (mean=0, variance=1) for 1000 samples.

A: The MATLAB code to generate white Gaussian noise is”

```
noise = randn(1,1000);
```

CIRCUIT ANALYSIS

13. Solve a DC circuit with resistors (3 Ω, 6 Ω) and voltage source (12 V) using nodal analysis.

```
Y = [1/3 + 1/6, -1/6; -1/6, 1/6]; % Conductance matrix
I = [12/3; 0];                    % Current vector
V = Y\I;                          % Node voltages
```

14. Simulate an RC circuit (R=1kΩR=1kΩ, C=1μFC=1μF) response to a 5V step.

A:

```
sys = tf(1, [1e-3, 1]); % Time constant RC=0.001s
step(5*sys);            % Step input of 5V
```

DIFFERENTIAL EQUATIONS

15. Solve $\frac{dy}{dt}$=−2y, y(0)=1 y(0)=1 for t∈[0,5].

A:

```
[t, y] = ode45(@(t,y) -2*y, [0 5], 1);
plot(t,y);
```

16. Symbolically integrate $\int_0^1 x^2\,dx$

A:

```
syms x;
int(x^2, 0, 1) % Output: 1/3
```

17. Find Laplace transform of $e^{-at}sin(bt)$

A:

```
syms a b t;
laplace(exp(-a*t)*sin(b*t));
```

POWER SYSTEMS ANALYSIS

18. A load draws 100 kW at 0.8 lagging power factor from a 440 V (RMS) source. Calculate the complex power S and reactive power Q in MATLAB.

A:

```
P = 100e3; % W
pf = 0.8; % lagging
Vrms = 440; % V
S = P / pf; % Apparent power (VA)
Q = S * sqrt(1 - pf^2); % Reactive power (lagging)
S_complex = P + 1i * Q; % S = P + jQ
fprintf('S = %.2f + j%.2f VA\nQ = %.2f VAR\n', real(S_complex),
imag(S_complex), Q);
```

MATLAB OUTPUT:

```
S = 100000.00 + j75000.00 VA
Q = 75000.00 VAR
```

19. A 100 MVA, 220 kV base system supplies a load of 50 MW at 0.9 lagging power factor (200 kV). Convert the load power to per-unit on the given base.

A:

```
base_MVA = 100;
base_kV = 220;
P_MW = 50;
pf = 0.9;
S_MVA = P_MW / pf; % Apparent power
S_pu = S_MVA / base_MVA; % Per-unit apparent power
fprintf('S_pu = %.4f pu\n', S_pu);
```

20. A 220/33 kV, 50 MVA transformer has a ±10% HV tap range in 16 steps. Compute the voltage step per tap (in kV).

    A:

```
tap_range_percent = 20; % ±10% → total 20% range
n_steps = 16; % Steps across full range
step_kV = (0.20 * 220) / n_steps;
fprintf('Voltage step per tap = %.4f kV\n', step_kV);
```