**Setup Table (can be hand written, blank table provided students):**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Joint/ axis** | **f1** | **f2** | **f3** | **f4** | **f5** | **f6** | **f7** | **f8** | **f9** | **f10** | **f11** | **f12** | **f13** | b |
| **1** | **2/H** | 0 | **1** | 0 | 0 | 0 | **-1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | **2/V** | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **10** |
| **3** | **3/H** | **0.7071** | 0 | 0 | **-1** | **-0.7071** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 |
| **4** | **3/V** | **- 0.7071** | 0 | **-1** | 0 | **-0.7071** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0 |
| **5** | **4/H** | 0 | 0 | 0 | **1** | 0 | 0 | 0 | **-1** | 0 | 0 | 0 | 0 | 0 | 0 |
| **6** | **4/V** | 0 | 0 | 0 | 0 | 0 | 0 | **-1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **7** | **5/H** | 0 | 0 | 0 | 0 | **0.7071** | **1** | 0 | 0 | **-0.7071** | **-1** | 0 | 0 | 0 | 0 |
| **8** | **5/V** | 0 | 0 | 0 | 0 | **0.7071** | 0 | **1** | 0 | **0.7071** | 0 | 0 | 0 | 0 | **15** |
| **9** | **6/H** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | **-1** | 0 |
| **10** | **6/V** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | **20** |
| **11** | **7/H** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | **0.7071** | 0 | 0 | **-0.7071** | 0 | 0 |
| **12** | **7/V** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **-0.7071** | 0 | **-1** | **-0.7071** | 0 | 0 |
| **13** | **8/H** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0.7071** | **1** | 0 |
|  | **Coefficient Matrix (M)** | **b** |

**MATLAB Solution** (using right division approach)

>> format Bank

>> [1:13; (M\b)']

ans =

 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00

 -28.28 20.00 10.00 -30.00 14.14 20.00 0 -30.00 7.07 25.00 20.00 -35.36 25.00

Students should also put these numbers into a fully formatted table ready to be put into a report (see Table 1).

**Formatted table**

**Table 1:** Forces in Truss

|  |  |
| --- | --- |
| **Member #** | **Force (Tons)** |
| 1 | -28.28 |
| 2 | 20.00 |
| 3 | 10.00 |
| 4 | -30.00 |
| 5 | 14.14 |
| 6 | 20.00 |
| 7 | 0.00 |
| 8 | -30.00 |
| 9 | 7.07 |
| 10 | 25.00 |
| 11 | 20.00 |
| 12 | -35.36 |
| 13 | 25.00 |

1. **Script Exercise:**Write a program to calculate the magnitude and angle of a complex number
* **Input:** Use interactive input (i.e., the input function) to have user input a complex number
* **Output:** magnitude (M) and
 angle(θ) – in degrees
 Clearly label the output using the ***disp*** function.
* **Comments:** Introduction: Program name & purpose; your name & the date
 Variables: Define the name, nature and units of all script variables.
 Organize these variables as input, output and intermediate variables
 Program Logic: Clearly comment on steps including input, calculations and output;
 Label output with the ***disp*** function
* **Validation:** test with 1 + 2i from above (Eulerian form: M ~ 2.236 θ ~ 63.4o)

Include a hand calculation for the test case, the complete script with full comments (i.e., use the script template) and execution of the script for the test case.

**Script (code)**

% program cart2polar.m

% S. Scott Moor January 2015

% This script will determine the magnitude and angle for a complex number.

% This script can handle vector input

% Variables:

% cart = Cartesian complex number (e.g, 2 + 3i)

% M = magnitude of the number

% Theta = angle of number

% Input

cart = input('Enter a complex number in Cartesian Form: ')

% Calculate and display the magnitude and angle

disp('Complex Number in Polar Form ')

disp('The magnitude is:')

M = abs(cart)

disp('The angle (in degrees) is:')

Theta = angle(cart)

 **Execution:**

>> cart2polar

Enter a complex number in Cartesian Form: 1 + 2i

cart =

**Validation (via hand calculation):**

Cart = 1 + 2i, i.e., a = 1, b = 2

Magnitude $= \sqrt{a^{2}+ b^{2}}= \sqrt{1^{2}+ 2^{2}}= \sqrt{5 }=2.236$

Angle (radians) $=tan^{-1}\left(\frac{b}{a}\right)=tan^{-1}\left(\frac{2}{1}\right)=1.107 radians$

Angle (degrees)$ =1.107\left(\frac{180 degrees}{π}\right)= 63.435$ o

 M = 2.236, θ = 63.435o 🡺 Matches code to 5 sig. figures.

 1.0000 + 2.0000i

Complex Number in Polar Form

The magnitude is:

Mag =

 2.2361

The angle (in degrees) is:

Thetad =

 63.4349

1. **Extra Credit: Using Complex Numbers for Phasor Circuit Calculations**

For the circuit shown in Figure 1 the resulting phasor equations for the current, the voltage across the resistor and the voltage across the inductor are presented in equations 1 – 3. The details of these equations are being covered in class and the class slides.

 $I=\frac{10}{\left(5+1.2πj \right)}$ (1)

**Figure 1**: RL circuit from Class.

$V\_{R} = I (5)$ (2)

$V\_{L} = I (1.2π j)$(3)

*where: I* = current in the loop (Amp.)

 *VR* = voltage drop across the resistor (Volts)

 *VL* = voltage drop across the inductor (Volts)

1. Use MATLAB expressions to calculate the phasors in Cartesian form (i.e., enter the above equations in the command window) for:
	1. the current, *I*
	2. the resistor voltage, *𝑉𝑅* and
	3. the inductor voltage, *𝑉𝐿*
2. MATLAB expressions to determine the polar phasors for each of the above (you may use the script created in part b)

These steps may be done in the command window or with script

>> % 1.a the current

>> I=10/(5 + 1.2\*pi\*j)

I =

 1.2751 - 0.9614i

>> % 1.b. the resistor voltage

>> VR = I\*5

VR =

 6.3756 - 4.8071i

>> % 1.c. the inductor voltage

>> VL = I\*1.2\*pi\*j

VL =

 3.6244 + 4.8071i

See next page for number 2. Solved using the script from part b.

>> % 2.a the current

>> cart2polar

Enter a complex number in Cartesian Form: I

cart =

 1.2751 - 0.9614i

The complex number is:

The magnitude is:

Mag =

 1.5969

The angle(in degrees)is:

Thetad =

 -37.0156

>> % 2.b. the resistor voltage

>> cart2polar

Enter a complex number in Cartesian Form: VR

cart =

 6.3756 - 4.8071i

The complex number is:

The magnitude is:

Mag =

 7.9847

The angle(in degrees)is:

Thetad =

 -37.0156

>> % 2.c. the inductor voltage

>> cart2polar

Enter a complex number in Cartesian Form: VL

cart =

 3.6244 + 4.8071i

The complex number is:

The magnitude is:

Mag =

 6.0203

The angle(in degrees)is:

Thetad =

 52.9844

>