Answer all the following questions || No. of questions : 6 || Total Mark: 100 Marks

**Question (1) (10 Marks)**

Which of the following is a suitable user-defined function name? Explain your answer.

Switch – while – add2 – input – 2add

Answer

<table>
<thead>
<tr>
<th>Name</th>
<th>Valid or not</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch</td>
<td>valid</td>
<td>the first letter is capital, which is different from the reserved word “switch”</td>
</tr>
<tr>
<td>while</td>
<td>not valid</td>
<td>reserved word</td>
</tr>
<tr>
<td>add2</td>
<td>valid</td>
<td></td>
</tr>
<tr>
<td>input</td>
<td>not valid</td>
<td>reserved word</td>
</tr>
<tr>
<td>2add</td>
<td>not valid</td>
<td>begin with number</td>
</tr>
</tbody>
</table>

**Question (2) (10 Marks)**

What is the value of “r” in the following Matlab Expressions?

a) \( r = \text{round}(2.51) \)

b) \( r = \text{ceil}(2.51) \)

c) \( x = [2, 3, 4] \)
\( y = [1, 2] \)
\( r = x - y \)

d) \( x = 1; \)
\( y = 23; \)
\( r = 1; \)
\( \text{if} \ (x > 0) \)
\( r = 2; \)
\( \text{elseif} \ (y < -2) \)
\( r = 3; \)
\( \text{else} \)
\( r = 4; \)
\( \text{end} \)

Answer

a) \( r = 3 \)

b) \( r = 3 \)

c) error, dimension mismatch

d) \( r = 2 \)

**Question (3) (20 Marks)**

Answer the following questions for the array shown here.

\[
C = \begin{bmatrix}
1 & 4 & 5 \\
5 & 1 & 4 \\
2 & 3 & 10
\end{bmatrix}
\]
a) What is the size of C?
b) What is the value of C(2,3)?
c) List the subscripts of all elements containing the value 5
d) Write a code to find the index of all elements whose values are greater than 9

Answer
a) \( \text{Size} (C) = [2, 2] \)
b) \( C(2,3) = 4 \)
c) \( \text{Subscript} = [2, 7] \)
d) \( \text{find}(C>9) \)

**Question (4) (10 Marks)**

Sketch the results of executing the following code

```plaintext
figure
subplot(2,2,1)
x = 0:pi/10:2*pi;
y1 = sin(x);
plot(x,y1);
subplot(2,2,4)
y2 = cos(x);
plot(x,y2);
```

**Answer**

<table>
<thead>
<tr>
<th>Sin(x) here</th>
<th>Cos(x) here</th>
</tr>
</thead>
</table>

**Question (5) (30 Marks)**

a) What is the meaning of saying that VHDL is a strongly-typed language?
b) What is the difference between ASIC and FPGA designs?
c) What is the difference between fixed and variable-step options of the Simulink solvers?
d) How to improve the resolution of the simulated signals on Simulink?
e) The Simulink blocks are designed to accept signals and parameter values as vector inputs, what the benefits of that?
f) Sketch the subsystem block whose mask is defined by the code in the following figure:

```plaintext
Visible
text(5,10, 'Fourier')
Icon transparency
port_label('output', 1, 'FS out')
Opaque
dual_mode
port_label('input', 1, 'Sin 1')
Icon units
port_label('input', 2, 'Sin 2')
```
**Answer**

a) VHDL is a strongly-typed language means an object can only be assigned with a value of its type

b) The difference between ASIC and FPGA designs:

<table>
<thead>
<tr>
<th>ASIC</th>
<th>FPGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designs must be sent for expensive and time consuming fabrication in semiconductor foundry</td>
<td>bought off the shelf and reconfigured by designers themselves</td>
</tr>
<tr>
<td>designed all the way from behavioral description to physical layout</td>
<td>No physical layout design;</td>
</tr>
<tr>
<td>Higher performance</td>
<td>Design ends with a bit-stream used to configure a device</td>
</tr>
<tr>
<td>Low Cost (only in mass-volume)</td>
<td>Low development cost</td>
</tr>
<tr>
<td>Low power consumption</td>
<td>Short time to market</td>
</tr>
<tr>
<td></td>
<td>Reconfigurable</td>
</tr>
<tr>
<td></td>
<td>it is possible to implement a complex logic design in a manner which is easy to test, debug and even change using software the behavior of the design</td>
</tr>
</tbody>
</table>

c) The difference between fixed and variable-step options of the Simulink solvers:

- With a fixed-step solver, the step size remains constant throughout the simulation
- With a variable-step solver, the step size can vary in an adaptive fashion from step to step to maximize efficiency, while meeting specified error tolerances

d) To improve the resolution of the simulated signals on Simulink:
change the step size from auto to small values like 1e-4

e) The benefits of making the Simulink blocks accept signals and parameter values as vector inputs:
is to use this vector parameters to deals with multiple inputs and produce multiple outputs

f) Sketch of the output block:
**Question (6) (20 Marks)**

When a ray of light passes from a region with an index of refraction \( n_1 \) into a region with a different index of refraction \( n_2 \), the light ray is bent (check the Figure). The angle at which the light is bent is given by Snell’s law:

\[
n_1 \sin \theta_1 = n_2 \sin \theta_2
\]

Where \( \theta_1 \) is the angle of incidence of the light in the first region and \( \theta_2 \) is the angle of incidence of the light in the second region. Using Snell’s law, it is possible to predict the angle of incidence of a light ray in Region 2 if the angle of incidence in Region 1 and the indices of refraction and are known. The equation to perform this is:

\[
\theta_2 = \sin^{-1}\left(\frac{n_2}{n_1} \sin \theta_1\right)
\]

- Write a program to calculate the angle of incidence (in degrees) of a light ray in Region 2 given the angle of incidence in Region 1 and the indices of refraction.
- If , then for some angles , the required angle will have no real solution, because the absolute value of the quantity will be greater than 1.0. When this occurs, all light is reflected back into Region 1, and no light passes into Region 2 at all. Your program must be able to recognize and properly handle this condition.

**Answer**

```matlab
%% This code to calculate the angle of refraction in the second medium
%% It may be solved using user-defined function or m-file script as this one

n1 = 1.2; % refractive index of the first medium
n2 = 1.3; % refractive index of the second medium
theta_1 = 30; % Angle of incidence in the first medium

%% Calculating the quantity
quant = n1*sind(theta_1)/n2;
if quant>=1
    display('Total Internal reflection case, all incident wave is reflected back ')
else
    display('Angle in the second medium is: ')
    theta_2 = asind(quant)
end
```