Q1: An OP-AMP with open loop gain of 100dB, input resistance is 100kΩ, pole frequency $f_p$ of 100Hz, and zero output resistance.

(i) plot the asymptotic gain-frequency response and determine its GB product,
(ii) find the input resistance of a voltage follower based on this OP-AMP.

Q2: For the low pass filter, given

- The D.C. gain is -10 and
- $W_c=100$ rad/s. Use $R_2=100kΩ$.

(i) derive the s-domain transfer function,
(ii) determine the required $R_1$, and $C_1$,
(iii) plot the filter response in dB scale.

Q3: For the FET amplifier shown:

given FET parameters $g_m=0.2s$, $r_d=10kΩ$, $R_s=1kΩ$, and $R_g=500kΩ$,

(i) determine the Feedback topology,
(ii) calculate $A$, $\beta$, $D$, $A_f$, and $A_{vf}$.
Q4: Derive the oscillation conditions for the tuned circuit oscillator shown in terms of transistor parameters $h_{ib1}$ and $h_{fb}$ as well as the transformer turn ratio and other circuit elements.

Q5: For the Astable multivibrator shown given: $R_1=10k\Omega$, $R_2=1k\Omega$, $C=1\mu F$, and the OP-AMP is biased from ±10v:
(i) draw the output and capacitor Voltages,
(ii) derive and calculate the output Frequency.

Q6: A class-B push pull power amplifier drives a load of $8\Omega$, 0.5w. Assume the D.C. power supply is 9 volt and transistors have $V_{Cesat}=1$ volt. Determine the output transformer turn ratio, D.C. input power, $\eta$, and the power dissipated by each transistor.
Q1/ Write first a behavioral VHDL code that represent a multiplexer 4*1, then use it as a structure to build a multiplexer 16 *1 as shown in the figure below.

Q2/ Write a behavioral VHDL code that represent a four bit shift right register with asynchronous reset. Its block diagram is drawn below.
Where Ld : Shift bar/ load, Ser: serial input; R: reset
Q3/ How could you draw a logical circuit of asynchronous system using SR latch that has the following primitive flow table? Write all the tables needed to obtain a good design.

<table>
<thead>
<tr>
<th></th>
<th>m, n (I/P)</th>
<th>Z (O/P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A B C</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>A B D</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>F C E</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>H G D</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>H G E</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>F B C</td>
<td>1</td>
</tr>
<tr>
<td>G</td>
<td>F G E</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>A H D</td>
<td>1</td>
</tr>
</tbody>
</table>

Q4/ a) Write against each of the following standard buses its type (Parallel or Serial) and its data rate.
IEEE 488, IEEE 1394, USB

b) Define the standard bus RS232C in detail. List the famous connections.

Q5/ Implement the Boolean expression with a ladder program.

\[ Y = A B + A C + C \oplus D \]

According to this expression if \( Y \) is ON then a motor will run for 10 sec during that a green lamp is ON. At the end of the time a red lamp is ON for 20 sec then every thing is OFF.

Q6/ a) Draw the logical circuit of GAL 22V10

b) Put a suitable sign (\( \vee \)) or (\( \times \)) against each of the following:
1- The state bit EN in timer OFF instruction of the PLC equal to 1 when the rung is true.
2- SLL is an VHDL operator that shift left logical, filled with the right bit.
3- REM is an VHDL operator that mean remain.
4- There is no need to connect a decoder (2 to 4) for expanding a memory 64k* 4bit to 64k * 16bit.
5- GAL 16V8 could be used for a system of 14 inputs and 9 outputs.

With my best wishes
Q1) [4+4]

a) A discrete time signal is given by \( x(n) = \sin\left(\frac{2\pi n}{1024}\right) \)

1. What is the fundamental period.

2. What is the largest positive and negative frequencies that would result a signal in an aliasing?

b) For the discrete system described by the difference equation

\[ y(n) = 3y^2(n-1) - nx(n) + 4x(n-1) - 2x(n+1) \]

Check the system linearity, causality, and time dependency
Is the system FIR or IIR type?

Q2) [4+6+6]

In the cascade system shown below

\[ H_1(z) = \frac{1}{1+0.5z^{-1}}, \quad H_2(z) = \frac{1}{1-0.5z^{-1}}, \quad H_3(z) = b_0 + b_1z^{-1} + b_2z^{-2} + b_3z^{-3} \]

a) Find the coefficients \( b_0, b_1, b_2, \) and \( b_3 \) such that the overall input output relationship for the system is \( y(n)=x(n-1) \).

b) Assume that \( H_3(z) = \frac{1+0.5z^{-2}}{1+0.5z^{-1}+0.25z^{-2}} \), realize the overall system using cascade structure.

c) By using **time domain analysis**, find and plot \( w(n) \) as function of \( n \).

![Diagram](image)

Q3) [2+2+4+2]

If the impulse response of the system is given by

\[ h(n) = \begin{cases} 
  e^{-n} & 0 \leq n \leq 2 \\
  0 & \text{elsewhere}
\end{cases} \]

a) Find the transfer function of the system.

b) Plot pole-zero diagram of the system.

c) Determine the frequency response of the system (magnitude & phase).

d) Give difference equation of the system.
Q4) [5+5]

a) By using radix2 DIT FFT, find the DFT of the sequence \( x(n) = \{1, 1.5, 0.5, 2\} \).
Sketch the system.

b) Determine the inverse DTFT of the following function

\[
H(\Omega) = j\left(\frac{11}{2} + 2 \cos \Omega + \frac{3}{2} \cos(2\Omega)\right) \sin\left(\frac{\Omega}{2}\right) e^{-j\frac{\Omega}{4}}
\]

Q5) [4+6+6]

a) Explain the types of linear phase FIR filters.

b) The coefficients of a lattice FIR filter are \( k_1 = -0.266 \) and \( k_2 = 0.69 \). Draw the realization diagram for the filter, and find the output \( y(n) \) from diagram.

c) A lowpass digital filter has poles and zero at the following locations

- zero: -0.5
- poles: 0.37, 0.6 \( \pm j0.5 \)

Determine the coefficients of this filter
Q1/ A- A linear resistance potentiometer is 50mm long and is uniformly wound with a wire having 10KΩ. Under normal condition, the slider is at the center of the center of the potentiometer as measured by a Wheatstone bridge for two cases are 3850Ω and 7560Ω respectively.

a. Are the two displacements in the same direction?
b. If it's possible to measure a minimum value of 10Ω resistance with above arrangement, find the resolution of the potentiometer in mm.

(7 Marks)

B- Draw the block diagram of heart beat monitoring (ECG) equipment. Show the job of the isolation amplifier on its operation.

(5 Marks)

Q2/A- Draw the basic block diagram of CRO oscilloscope showing the basic component of it, and show the purpose of time base generator on it.

B- For the bridge as shown:

a) Is this bridge circuit in complete balance? If not, specify two ways in which it can be made to balance, for X as given. (Give numerical values of any additions).
b) Find the voltage across the detector terminals for the original bridge, assuming the detector to have very high impedance.

(10 Marks)

Q3/ A- How can you check a short circuit fault in telephone companies using Murray loop test?

B- For the circuit shown below:

a. What type of signal does the circuit produce?
b. Find the frequency and peak-to-peak output voltage. Knowing that the saturated output voltages for the comparator are ±15V.
c. How you can change the frequency of oscillation to 10 KHz.
d. If VIN=4V, what is the rate of change of the output signal?

(8 Marks)
Q4/ A- Draw the block diagram of Successive- approximation DVM, state the purpose of a sample and hold circuit. (6 Marks)

B- Define each of the following: (4 Marks)
1- Thermocouple.
2- Form factor.
3- CMRR.
4- Sample- rate multivibrator.

Q5/ A- Shunt type ohmmeter, as shown in figure use a 10 mA basic d'Arnoval movement with an internal resistance of 5Ω. The battery voltage E=3V. It is desired to modify the circuit by adding an appropriate resistor $R_{sh}$ across the movement, so that the instrument will indicate 0.5Ω at the midpoint on its scale. Calculate (6 Marks)

a) The value of the shunt resistor $R_{sh}$.
b) The value of the current limiting resistor.

B- Fill in the blanks with proper answer (may be word or statement) :- (3 Marks)

1. To solve the problem of mutual inductance in measurement system we have to use………………and to overcome the capacitive coupling we use………………………….
2. The gain of instrumentation amplifier can be set by………………
3. When you want to transmit a thermocouple out signal, it is better to transmit it through……………………. Because it not suffers from…………………
4. The output of piezoelectric transducer is proportional to…………………

WITH MY BEST WISHES
Q1)

A. Convert the following IEEE 754 floating point number formats to real numbers:

1. 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

2. 1 0 1 1 1 1 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

B. Write an assembly subroutine that sorts X array using bubble sorting algorithm. X is a 32-bit signed integer array of size 1000 elements.

X dd 1000 dup(?)

Q2)

A. Design the hardware required to implement the following digital filter:

![Diagram](image)

Use the following:
1. Interface DAC0808 at port address 3f00h and set up Vmax = 5 Volt.
2. Interface ADC0809 at port address 3f01h and use EOC of AD0809 to generate INT signal to the microprocessor. Use interrupt number 90h.

B. Write a piece of code to realize the following digital filter. Use fixed point arithmetic with 5-bit fraction.

\[
H(z) = \frac{Y(z)}{X(z)} = \frac{1 + 0.231 \times z^{-1} + 0.315 \times z^{-2}}{1 + 0.357 \times z^{-1} + 0.417 \times z^{-2}}
\]

Q3)

A. X is a square matrix of size 32 X 32 (8-bit signed integer) is stored in computer memory as row major. Write a piece of code to compute the average of the elements in the last row of X matrix. Store the result in av. Where:

X DB 1024 dup(?)
av DB 0
B. Compute the time delay generated by the following subroutine:

```
Delay PROC NEAR
    PUSH CX
    MOV CX,0
    NEXT:  PUSH CX
          POP CX
          LOOP NEXT
          POP CX
          RET
Delay ENDP
```

**Given the following:** 8086 speed is 4 MHz, call 19T, ret 16T, mov reg, data 4T, push reg 11T, pop reg 8T, loop 17/5 T.

Q4)
Design the hardware required for interfacing the 8086 demultiplexed buses to the following system memory:
1. 128 Kbyte of ROM using 16 Kx8 ROM chips starting at address E0000h.
2. 64 Kbyte of SRAM using 8 Kx8 SRAM chips starting at address 00000h.

Q5)
A. X and Y are two sorted arrays; each of size 1024 byte. Z is an array of size 2048 byte. Write a piece of code to merge (دمج) the two arrays X and Y in Z array so that the Z array is also sorted array without resorting the Z array.

B. Write a piece of code to add two 64-bit unsigned integers (X and Y) and store the result in Z (64-bit unsigned integer). Given the following declaration:
   
   ```
   X DQ ? ; X is 64 bit unsigned integer
   Y DQ ? ; Y is 64 bit unsigned integer
   Z DQ ? ; Z is 64 bit unsigned integer
   ```
Question 1 // (12 points)

For the given Modulator having the following output current equation for the diode:

\[ I(t) = 0.8 [V_{in}(t)] + 0.1 [V_{in}(t)]^2 \]

- Find the input voltage equation of the diode \( V_{in}(t) \),
- Find the output voltage equation \( V_0(t) \),
- Draw the frequency spectrum diagram of \( V_0(t) \),
- Find \( V_0(t) \) after a band-pass filter of a center frequency \( \omega_c \) and a bandwidth of \( 2\omega_m \).
- Find the total power output \( P_t \) after the filter.

Given that: \( m(t) = 2 \cos(\omega_m t) \);
\[ C(t) = 4 \cos(\omega_c t) \]

Question 2 // (16 points)

Using the given \( V_D \) and \( I_D \) equations at any point (D) on the transmission line, of propagation constant \( y \), at a distance \( x \) from the sending end and at a distance \( d \) from the receiving end of the line, Derive the following reflection coefficient factor equation \( k_D(\nu) \) at point (D).

\[ k_D(\nu) = k_R \cdot e^{-2yd} \quad \text{Where:} \quad V_D = A \cdot e^{-\nu x} + B \cdot e^{+\nu x} \]
\[ k_R(\nu) = (Z_R - Z_0) / (Z_R + Z_0) \]
\[ I_D = (A \cdot e^{-\nu x} - B \cdot e^{+\nu x}) \cdot (1/Z_0) \]

Question 3 // (12 points)

For the given Loss-free transmission line:
- Find the VSWR of T.L, using the given smith-chart;
- Find the admittance (\( Y_R \)) of the load;
- Find the input impedance (\( Z_0 \)) at the sending end of T.L;
- How far is the first minimum voltage point from \( Z_R \);
- How far is the first maximum voltage point from \( Z_R \);
- Find the reflection coefficient factor at the receiving end (\( K_R = ? / ? \)).
- Find the reflection coefficient factor at the sending end (\( K_S = ? / ? \)).
- Find the value of the equivalent input impedance at the first minimum voltage point.
- Find the value of the equivalent input impedance at the first maximum voltage point.

Question 4 // (20 points)

1. For DSB-AM Amplitude Modulation: Prove that the signal to noise power ratio at the output of the detector is twice that at the input of the detector in the receiver. \[ \frac{S_o}{N_o} = 2 \left[ \frac{S_i}{N_i} \right] \]

2. An FM wave is defined by: \( S(t) = 10 \cos[80\pi 10^6 t + 2 \sin(8000\pi t)] \); Find:
   - The instantaneous frequency equation \( f(t) \) of the above \( S(t) \);
   - The frequency deviation (\( df \));
   - The modulation index (\( m_f \));
   - The Bandwidth of this FM wave;
   - With a frequency sensitivity of (3.2 kHz/volts), find the amplitude of the modulating signal;
   - The total power of the modulated wave; Given that \( R = 1 \) \( \Omega \).
PART 1: Electronic and Communication Lab

Q1/- The frequency response of a filter circuit is given in the table below, find the

1- Type of the filter.
2- Cutoff frequency.
3- Voltage gain.

Note that (Vin = 3 Vp-p)

<table>
<thead>
<tr>
<th>F(Hz)</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1000</th>
<th>1100</th>
</tr>
</thead>
<tbody>
<tr>
<td>V0(p-p)</td>
<td>3</td>
<td>3</td>
<td>2.9</td>
<td>2.7</td>
<td>2.6</td>
<td>2.38</td>
<td>2.29</td>
<td>2.23</td>
<td>2.12</td>
<td>1.7</td>
<td>1.3</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Q2/- For VCO-LO circuit block, if the message signal is the sine wave as shown in the figure below, calculate the frequency deviation (ΔF) if the frequency carrier = 510kHz, then calculate the bandwidth frequency for an FM signal? Use the following table.

![VCO-LO circuit block schematic.]

<table>
<thead>
<tr>
<th>VT [volt]</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
<th>-4</th>
<th>-5</th>
<th>-6</th>
<th>-7</th>
<th>-8</th>
<th>-9</th>
<th>-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Output Freq. [kHz]</td>
<td>500</td>
<td>510</td>
<td>520</td>
<td>530</td>
<td>540</td>
<td>550</td>
<td>560</td>
<td>570</td>
<td>580</td>
<td>590</td>
</tr>
</tbody>
</table>

Q3/- For the inverting OP-AMP circuit below, if you know that the unity gain bandwidth of the OP-AMP is 10MHz find the:

1- Bandwidth of the given circuit.
2- Draw the output signal with respect to: a- Vin= 5sin (2π*10⁴*t)
   b- Vin=5 V_{d.c}
Q4/- How you can generate a sine wave signal by using 555 IC signal generator? What's the frequency of the signal will be. How can calculate the duty cycle?

Q5/- Design a class C power amplifier to duplicate an input signal of 200KHz. use the circuit below?

Q6/- Using 74191 IC (4-bit binary counter) shown and other components or Gates you need. Design a counter circuit that counting from 2H to 9H with 1 second between each count.

Q7/- Thermistor resistance value is measured at T = 30°C and it was 4KΩ, use the following table to verify that is in the acceptable rang or not. Why?

<table>
<thead>
<tr>
<th>°C</th>
<th>RESISTANCE RATIO</th>
<th>TEMPERATURE COEFFICIENT</th>
<th>RESISTANCE DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.2658</td>
<td>5.1</td>
<td>1.5</td>
</tr>
<tr>
<td>5</td>
<td>2.5391</td>
<td>5.0</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>1.9898</td>
<td>4.8</td>
<td>0.8</td>
</tr>
<tr>
<td>15</td>
<td>1.5710</td>
<td>4.6</td>
<td>0.5</td>
</tr>
<tr>
<td>20</td>
<td>1.2491</td>
<td>4.5</td>
<td>0.2</td>
</tr>
<tr>
<td>25</td>
<td>1.0080</td>
<td>4.4</td>
<td>0.0</td>
</tr>
<tr>
<td>30</td>
<td>0.8057</td>
<td>4.3</td>
<td>0.4</td>
</tr>
<tr>
<td>35</td>
<td>0.6531</td>
<td>4.2</td>
<td>0.7</td>
</tr>
<tr>
<td>40</td>
<td>0.5327</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td>45</td>
<td>0.4369</td>
<td>3.9</td>
<td>1.3</td>
</tr>
<tr>
<td>50</td>
<td>0.3683</td>
<td>3.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Q9/- Write an equation of AM signal with a carrier of 0.8 V and 1.4 MHz frequency. Also, the audio (sine wave) signal with 4 KHz is modulated with m = 0.75.

Q9/- For the following block diagram, Given $V_{antenna}$ as shown in figure 1:

a) Sketch $V_{osc}$, $V_{IF}$ and $V_{audio}$.
b) What is the class of the power audio amplifier? Why we use this class?

![Block Diagram of AM Signal](image)

Q10/- For the given square wave signal
- Amplitude (A) = 10 volt.
- Frequency (F) = 500 Hz.
- Phase shift = 0.

Calculate the parameter of the following equation.

$$V(t) = A \sin(w_1)t + B \sin(w_2)t + C \sin(w_3)t + D \sin(w_4)t.$$  

B = _______, C = _______, D = _______,  

$w_1$ = _______, $w_2$ = _______, $w_3$ = _______, $w_4$ = ________

Q11/- Design Colpitts oscillator to generate sine wave with frequency equal to 3 KHz, with gains equal 10.

![Colpitts Oscillator Circuit](image)

L1 = __________, C3 = __________, C5 = __________

Q12/- Choice the correct answer:

A- The point where amplifier high frequency gain has dropped 30% is  
 a. the crossover point.  
 b. the upper frequency limit (F2).  
 c. unaffected by feedback.  
 d. the point where distortion sets in.
B- When the number of poles of a low pass filter circuit is increased, the
   a. frequency response moves closer to the ideal.
   b. frequency response does not change.
   c. frequency response moves further from the ideal.
   d. circuit becomes unstable.

C- If a loud speaker with a resistance of 5 ohms and a 10 Vrms voltage drop is the output of a single-ended power amplifier, what is the output power of the amplifier?
   a. 50 mW
   b. 2.5 mW
   c. 2W
   d. 20W

D- Which circuit in the RECEIVER section of ultrasonic transducer removes the 40 kHz signal?
   a. AMP
   b. DETECTOR
   c. VOLTAGE COMPARATOR
   d. None of the above.

E- In Thermistor Bridge, According to the output voltage formula:
   \[ V_{OUT} = (T - 30^\circ C) \cdot 0.6 \text{ V/}^\circ \text{C} \]

   The calibration voltage is must equal to:
   a. 6V
   b. 4V
   c. 7V
   d. 5V

F- The purpose of negative feedback is to
   a. reduce the number of components in an amplifier.
   b. increase the transistor life.
   c. improve the gain and bandwidth of an amplifier.
   d. limit the amplifier output.

G- What is the frequency of the ultrasonic sound waves transmitted by the transducer?
   a. 109 Hz
   b. 40 KHz
   c. 100 KHz
   d. cannot be determined

H- The output transformer in a push-pull amplifier
   a. combines the two collector signals into one output signal.
   b. matches the circuit to the low impedance load.
   c. furnishes a dc path for the collector supply voltage.
   d. All of the above.

I- If the current drawn by the load of a shunt regulator circuit increases,
   a. regulating transistor current increases.
   b. regulating transistor current may increase or decrease.
   c. regulating transistor current decreases.
   d. output voltage (Vo) increases.

J- If you know a band pass filter's center frequency and lower cutoff frequency, how can you determine the upper cutoff frequency?
   a. by doubling f1.
   b. by subtracting f1 from fc and adding the result to fc.
   c. by doubling fc.
   d. cannot be determined.
Q13- Draw the block diagram of digital sound recorder and explain briefly the function of each component. [4 mark]

Q14- ASK amplitude shift keying is one of digital modulation technique. One binary digit represented by presence of carrier, at constant amplitude. Other binary digit represented by absence of carrier according to the equation:

\[ s(t) = \begin{cases} 
A \cos(2\pi f_c t) & \text{binary 1} \\
0 & \text{binary 0} 
\end{cases} \]

Where \( A \cos(2\pi f_c t) \) represents the carrier signal.

Write an assembly language program to modulate this data (10110010) using the analog to digital converter. Assume bit rate (one bit time) is 0.5 kbps and the carrier frequency \( f_c \) is 1 kHz. 

*Hint*: 8086 frequency is 2.5 MHz, DAC address is 3FD8H. [5 mark]

Q15- By using Debug write a program that displays the following information:

A name / year of birth / city name

The maximum number of displayed characters should not be more than 20 characters, and the information should be displayed only after the star (*) key from the keyboard is pressed. *(The information you typed after executing the program will appear on the screen after the * key is pressed from the keyboard)*

*Note 1*: The ASCII code of the (*) key is "2A" hex.

*Note 2*: Do not write your name in the answer or any other information. [5 mark]

Q16-

A- Write the meaning of the following mnemonic of the 8086 instructions and explain the work of the instruction:

1. LES
2. RCL
3. JNGE
4. SBB
5. SAHF
6. STOSW
7. JCXZ
8. STC
9. ADC
10. CBW [2 mark]
B- Explain briefly the meaning of this expression:

\[ H A B \]

and write down the equivalent assembly language program. [2 mark]

C- list down all the necessary commands needed to create the file Myfile.HEX using micro assembler. Explain the input and the output file type in each step. Arrange your answer in a table like bellow:

<table>
<thead>
<tr>
<th>Step description</th>
<th>Input</th>
<th>command</th>
<th>output</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

[2 mark]
Materials provided: semilog paper, Nichol’s chart, and Cm-Square graph paper

Q1:
A. Draw the basic electronic circuit used to realize PD-Controller and derive the transfer function of the circuit.
B. A control system with a PD-Controller is shown in figure below. Find the values of \( K_\theta \) and \( K_D \) so that the ramp-error constant \( K_v \) is (1000) and the damping ratio is (0.5).

\[
\frac{1000}{s(s+10)}
\]

(20 marks)

Q2:
One version of a space station is shown in figure below. It critical to keep this station in the proper orientation toward the sun and the earth for generating power and communication. The orientation controller may be represented by a unity feedback system with an actuator and controller

\[
G(s) = \frac{K(s+25)}{s(s^2 + 24s + 100)}
\]
Sketch the root locus for \( k > 0 \) and show on it:

a. The breakaway point on the real axis and the gain at this point (Note: breakaway point lie between \(-2.7\) and \(-2.5\)).
b. The range of values of \( K \) so that the system is over damped, critical damped, under damped, and negative damped.

Q3:
The open loop frequency response results of a control system are given as follows:

<table>
<thead>
<tr>
<th>W (rad/sec)</th>
<th>0.1</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
<th>1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude (dB)</td>
<td>20</td>
<td>13.8</td>
<td>7</td>
<td>2.7</td>
<td>-0.85</td>
<td>-4</td>
<td>-10.6</td>
</tr>
<tr>
<td>Phase (deg)</td>
<td>-98.6</td>
<td>-107</td>
<td>-123</td>
<td>-138</td>
<td>-150</td>
<td>-161</td>
<td>-183</td>
</tr>
</tbody>
</table>

Plot the frequency response results on a Nichol’s chart, then obtain the following:

a. Gain margin, phase margin, gain crossover frequency, and phase crossover frequency.
b. Peak resonance, resonant frequency, and closed-loop bandwidth.
c. Value of \( K \) for phase margin to be (60 deg).
d. Damping ratio and natural frequency.
e. Comment on the stability of the system.

Q4:
Consider the system shown in figure below. Design a lead compensator \( G_c(s) \) such that the closed-loop system will satisfy the following requirements:
Velocity error constant \( K_v = 20 \), phase margin = 50 deg, and gain margin \( \geq 10 \) dB.

Q5:
Consider the open-loop control system with digital filter shown in figure below, the digital filter solves the difference equation \( U(K) = U(K-1) + c(K) - e(K-1) \)
Find the unit step response \( C(KT) \) up to 3rd sampling instant.
Note: the sampling period \( T = 1 \) sec