Q1: An OP-AMP has the following characteristics: open loop gain=100dB, input resistance=100K, and has zero output resistance. This OP-AMP is used to realize a voltage follower circuit. Draw the voltage follower circuit and calculate its input resistance and voltage gain.

Q2: For the feedback circuit shown in fig(1), the transistors are identical with $h_{fe}=50$, and $h_{re}=2K$.
(i) Determine the feedback topology,
(ii) Draw the basic amplifier with feedback,
(iii) Calculate $A$, $\beta$, $D$, and $A_f$.

Q3: A phase shift oscillator uses a feedback circuit shown in fig(2) with an ideal op-amp.
(i) derive the oscillation conditions,
(ii) design the oscillator circuit for an output frequency of 10kHz,
(iii) sketch only the oscillator circuit if a FET amplifier is used instead of op-amp.

Q4: Design an astable multivibrator that produces a train pulse shown in fig(3). Use $n$-type transistor with $V_{Bsat}=V_{Cesat}=0$, $\beta=100$, and $I_{Cmax}=10mA$. Draw the circuit diagram and calculate the required element values.

Q5: A class-B push-pull power amplifier requires to give a maximum output power of 20W to 10$\Omega$ load, $V_{CC} = 40V$.
(i) Draw the a.c and d.c load lines,
(ii) Calculate the output transformer turn ratio,
(iii) Determine the power dissipation of each transistor, d.c. input power, efficiency, and the maximum transistor peak current.

Q6: The a.c circuit of a single tuned IF amplifier is shown in fig(4), the IF amplifier is required to be tuned at 455kHz and bandwidth of 10kHz. Given $L=7.45\mu$H, $R_t=5k$, $R_L=600\Omega$, $R_p=2.15k$, $r_{bc}=1k$, $C_{bc}=1000pF$, $C_{bc}=5pF$, and $g_m=0.1s$.
(i) calculate the transformer turn ratio,
(ii) the midband current gain.
Q1/ The following transition table have more than one race conditions. Find them and comment on their types.

<table>
<thead>
<tr>
<th>Present State</th>
<th>Next State x1x2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>00</td>
</tr>
<tr>
<td>00</td>
<td>01</td>
</tr>
<tr>
<td>01</td>
<td>11</td>
</tr>
<tr>
<td>10</td>
<td>00</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

Q2/ Write down a ladder program for a PLC to control the requirements of the following system. The system will be installed at the main gate of a supermarket, to calculate how many people will enter for the 1st hour of the day.
1- Temporary switches for ON and OFF.
2- A pause switch when it’s pressed it will stop calculating, for a certain period, but after releasing it the system will continue calculating people for absolute 60 minute.
3- Two lamps one that indicate calculating process and the other for a pause period.
4- At the end of the one hour if people are more than 100 a blue lamp is ON.

Q3/ a) Draw the output logic macrocell circuit for GAL22V10 then describe how it can be used as active high register mode.

b) List by its function all the integrated circuits that were used in the logical circuit of fastest finger first indicator project.

Q4/ Write a behavioural VHDL program that can be used as toggle (T flip flop) with asynchronous reset. The flip flop changes its data with the rising edge of the clock.

Q5/ a) How could you Expand a RAM memory of 512 * 2bit to a RAM of 2k * 4-bit.

b) Draw the hand shaking process in (IEEE488) standard bus.

Q6/ Obtain a primitive flow table and minimal row flow table for a fundamental mode asynchronous sequential network meeting the following requirements.
1- There are 2 inputs and one output.
2- The inputs never change simultaneously.
3- The output is to be 1 only both the input values are the same and the 2nd input x2 was the variable that changes its value causing the both input become the same.

With my best wishes
Taha A. Al-Sabbagh
Q1) [2+3+3+3+2]
A causal system is represented by the following difference equation:

\[ y(n) = x(n) + \frac{1}{2} x(n-1) + \frac{3}{4} y(n-1) - \frac{1}{8} y(n-2) \]

a) Find the system transfer function \( H[z] \).
b) From (a) find the impulse response of the system.
c) Find the frequency response, and determine its magnitude and phase.
d) Sketch the realization of the system using direct form II.
e) Is the system stable or not?

Q2) [4+5+5]
a) Determine the autocorrelation \( r_{xx}(n) \) of the signal \( x(n) = 0.35^n u(n) \).
b) Find Z.T of the signal \( x(n) = e^{-\alpha n} \sin(\frac{\pi n}{6}) u[n] \).
c) Let \( G[\Omega] \) is D.F.T of signal \( g(n) \), prove that D.F.T of \( g(n-n0) \) equal \( G[\Omega] e^{-j\omega n0} \).

Q3) [2+4+3+4]
a) Compute the value \( w_{56}^{3} \).
b) How much complex multiplications and additions are required for the best DIT FFT.
c) Given a three point in input other than zero stay in normal location.
d) Let \( x[k] \) represent D.F.T of the signal \( x(n) \) for \( k=0,1,2,\ldots,N-1 \), by using FFT explain how to evaluate the I.D.F.T.

Q4) [5+5+5+5]
a) Explain the digital filter design steps.
b) A requirement exists for an FIR digital filter to meet the following specifications:
Passband edge frequency 150-250 Hz
Transition width 50 Hz
Sampling frequency 1KHz
Stopband attenuation 50dB
Passband ripple 0.1dB
1) Sketch the tolerance scheme of the ideal and practical filter.
2) Calculate the first three coefficients of FIR digital filter using suitable window.
3) Realize the filter using direct form.

| Name of window function | Transition width (Hz) (normalized) | Passband ripple (dB) | Main lobe relative to side lobe (dB) | Stopband attenuation (dB) (maximum) | Window function $u(n)$, $|u| < (N-1)/2$ |
|-------------------------|-----------------------------------|----------------------|--------------------------------------|-------------------------------------|----------------------------------|
| Rectangular             | $0.9/N$                           | 0.7416               | 13                                   | 21                                  | $1$                              |
| Hanning                 | $3.1/N$                           | 0.0846               | 31                                   | 44                                  | $0.5 + 0.5\cos\left(\frac{2\pi n}{N}\right)$ |
| Hanning                 | $3.3/N$                           | 0.0194               | 41                                   | 53                                  | $0.54 + 0.46\cos\left(\frac{2\pi n}{N}\right)$ |
| Blackman                | $5.5/N$                           | 0.0017               | 57                                   | 74                                  | $0.42 + 0.5\cos\left(\frac{2\pi n}{N-1}\right) + 0.08\cos\left(\frac{4\pi n}{N-1}\right)$ |
Q1_A- Abridge is balanced at 1000Hz and have pure resistance ratio arms, AB 1500Ω, BC 1000Ω. The unknown arm is connected from C to D. Arm DA has a standard capacitor of 0.1μF and negligible internal resistance, to which is added a series resistance of 10Ω to give balance. The generator has an output of 15V and is connected from B to D. the detector is a high impedance voltmeter.

a. Find the constants of arm CD. 
b. Find the detector voltage for an increase of 10Ω in arm BC. (7 marks)

B- State the modes of oscillation in crystal used in the crystal controlled oscillator? Explain. (3 marks)

Q2_ A- You have Unknown resistance in the laboratory. Suggest with explaining a suitable connection of voltmeter-ammeter instruments to calculate the value of Rx. Knowing that the Rx value on rang 100KΩ-1MΩ. (5 marks)

B- If the relative error of voltmeter is about 98% from the maximum value of its value, calculate the value of the absolute error for reading about 175V on rang 300V, and the percentage of error of reading. (5 marks)

Q3_A- A series type ohmmeter, show in figure below uses a 50Ω basic movement requiring a full- scale current of 1mA. The internal battery voltage is 3V. The desired scale marking for half- scale deflection is 2000Ω. Calculate
a) the value of R1 and R2; b) the maximum value of R2 to compensate for a 10% drop in battery voltage; c) the scale error at the half -scale mark 2000 Ω when R2 is set as in part(b). (6 marks)

B- Draw the basic block diagram of Cathode ray oscilloscope showing the major subsystems on it. (6 marks)
Q4/ A- Draw the block diagram of ramp-type digital voltmeter; state the purpose of sample-rate multivibrator circuit.  
(7 marks)

B- Draw the circuit diagram of the instrumentation amplifier, and derive an expression for the overall gain.  
(8 marks)

Q5/ A- Fill in the blanks with proper answer (may be word or statement):

1. The RC feedback oscillators are generally suitable for frequencies up to about ..........While LC feedback oscillators are suitable for frequencies about ..........  
2. The simple and more popular type of displacement transducer is......................  
3. Sensitivity of the Wheatstone bridge can be calculated by converting the bridge to it’s.............  
4. In voltage transmission system that subject to common mode interference; the load voltage is unaffected by......................  
(5 marks)

B- For circuit shown in figure below:

1- What is the name of the circuit. Determine the necessary value of R₂ so that the circuit will oscillate.  
2- What is the initial closed loop gain, at what value of output voltage does A₂ change and to what value does it change.  
3- Explain the purpose of R₃.  
4- Find the frequency of oscillation for this circuit.  
(8 marks)

WITH MY BEST WISHES
Q1)

A.  
1. Convert the following integers into 8-bit signed and 16-bit signed binary formats:  
   i. 129  
   ii. -128  
2. Convert the following real numbers to IEEE 754 floating point number formats:  
   i. 15.625  
   ii. -0.5  

B. Write a piece of code to generate 2048 random numbers. Store the random numbers in X array. Given the following PN generator with initial value 444Fh.

   X DW 2028 dup(?)

Q2)

A. Design the required hardware for interfacing 8-bit digital to analog converter (DAC0808) to the 8086-microprocessor system bus (Set up the DAC so, Vmax = 10 volt). Use port address f310h in the design.

B. Write a piece of code to generate the following signal:

   \[ V_o = 4 \left( 1 + \sin(50\pi t) \right) \]  volt

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.

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 transpose of X matrix (i.e. \( X = X^T \)).

   X DB 1024 dup(?)

B. X is a 32-bit array of size 1024 elements. Write a piece of code to reverse the order of bits of each element of the array.
Q4)

A. Write a piece of code to exchange the value of bit4 with the bit3 of each byte of X array. The array size is 1024 byte. Given that:

\[ \text{byte} = \text{bit7} \ldots \text{bit0} \]

B. Design the hardware required for demultiplexing and fully buffering the 8086 buses in minimum mode operation.

Q5)

Design the hardware required for interfacing the 8086 demultiplexed buses to the following system memory:

1. 64 Kbyte of ROM using 32 Kx8 ROM chips starting at address F0000h.
2. 64 Kbyte of SRAM using 16 Kx8 SRAM chips starting at address 00000h.
Question 1 //
The output voltage of a transmitter is given by the following envelope wave form.
This voltage is fed to a load ( 100 Ω ). Find:
- Which type of modulation is this;
- The carrier frequency f_C ;
- The modulating frequency f_m ;
- The modulation index ;
- The carrier voltage E_C ;
- The carrier power P_C ;
- The modulating signal voltage E_m ;
- The upper and lower sideband frequencies;
- The bandwidth of the modulated wave.
- Draw the frequency spectrum diagram.

Question 2 //
In a Pulse Amplitude Modulator, The Carrier signal [ C(t) ] is a pulse train wave and can be represented by:
\[ C(t) = \begin{cases} +12 \text{ volts} & \text{at } 0 < t < 15 \micro\text{sec.} \\ 0 \text{ volts} & \text{at } 15 < t < 75 \micro\text{sec.} \end{cases} \]
The modulating signal is:
\[ m(t) = 2 \cos(\pi \cdot 10^5 t) \]
Derive the output equation [ S(t) ] of this Pulse Amplitude Modulator, and find:
- The peak amplitude of the carrier wave ,
- The pulse repetition frequency [ f_r Hz ].
- The pulse repetition time ,
- The pulse width.
- The Duty Cycle of the pulse.
- Draw the frequency spectrum diagram for ( n = 0, 1, 2 )

Question 3 //
Given the following Standing wave patterns of the resultant voltage for unknown load impedance (Z_R) connected at the receiving end of the T.L. of a characteristic impedance ( Z_0 = 50 [Ω] ), determine:
- The standing wave ratio – VSWR (S ) ;
- The reflection coefficient factor at the receiving end ;
- The minimum input impedance at maximum voltage point ;
- The minimum input impedance at minimum voltage point ;
- The wave length (λ ) and the frequency of the traveling voltage through the T.L.

Question 4 //
Loss-free, two parallel conductor, transmission line of a length (4.25 m) and (50 Ω) characteristic impedance operates with a frequency (120 MHz). The reflection coefficient factor due to unknown load (Z_R) at the receiving end is ( K_R = 0.7 \{-180°\} ).
- Find the VSWR due to the load of T.L. ;
- Find the value of the load (Z_R) at the receiving end of T.L. ;
- Find how-far is the first minimum voltage point from the load ;
- Find how-far is the first maximum voltage point from the load ;
- Find the equivalent input impedance at the sending end of the T.L ;
- Find the position and length of an open circuited single stub line used for matching the load to T.L. ;
PART 1: Electronic and Communication Lab

Q1/- For the shown waveform:
1- Write the equation of the signal \( e(t) \).
2- Plot the spectrum of the signal \( e(t) \).
3- Find the bandwidth of the signal \( e(t) \).

\[ e(t) \]

Q2/- From the figure shown below, find the duty cycle, trigger voltage level, threshold voltage level, and frequency of the signal.

\[ \text{Duty Cycle} \]
\[ V_{\text{trigger}} \]
\[ V_{\text{threshold}} \]
\[ \text{Frequency} \]
Q3/- 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.](image)

<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>

Q4/- The quality factor (Q) for the band pass filter circuit shown is (4.16); determine the bandwidth (BW) of the filter.

![Band pass filter circuit](image)

Q5/- 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- \(Vin = 5 \sin (2\pi \times 10^4 \times t)\)
b- \(Vin = 5 V_{dc}\)
Q6/- 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?

Q7/- Design a class C power amplifier to duplicate an input signal of 100KHz, use the circuit below?

Q8/- Thermistor resistance value is measured at $T = 30^\circ C$ and it was $4K\Omega$, use the following table to verify that is in the acceptable range 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>3.2650</td>
<td>5.1</td>
<td>1.5</td>
</tr>
<tr>
<td>5</td>
<td>2.8391</td>
<td>5.0</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>1.9890</td>
<td>4.8</td>
<td>0.6</td>
</tr>
<tr>
<td>15</td>
<td>1.5718</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>1.0003</td>
<td>4.4</td>
<td>0.2</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>0.4</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>1.5</td>
</tr>
<tr>
<td>50</td>
<td>0.3603</td>
<td>3.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Q9/- For the following circuit (AM detector) draws the signal at points $V_a$, $V_b$ and $V_o$?

Q10/- 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:
   \[ V_{OUT} = (T - 30^\circ C) \times 0.6 \text{ V/}^\circ C \]

   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.
PART2
Microprocessor LAB

1. Write a program to find the largest number within 10 bytes and display the largest one on the 7-segment display (address of 7-segment port=3ff0H).

2. M 200 250 300
   Explain briefly the meaning of the given expression and write down the equivalent assembly language program.

3. Draw the flow chart of digital sound recorder.

4. Explain briefly the meaning of the following:
   - Hardware interrupt
   - Software interrupt
   - Interrupt vector table
Materials provided: semilog paper

Q1:
A. Simplify the block diagram shown in figure below. Obtain the transfer function \( C(S) / R(S) \).

![Block Diagram](image)

B. A unity feedback system is characterized by an open-loop transfer function:

\[
G(S) = \frac{K}{S(S + 8)}
\]

Determine the gain \( K \) so that the system will have a damping ratio \( \zeta = 0.4 \). For this value of \( K \), determine the settling time, peak overshoot, peak time and steady state error for a unit step input. (20 marks)

Q2:
A unity feedback control system has

\[
G(S) = \frac{K}{S(S + 2)(S + 3)}
\]

Sketch the root locus and show on it the range of values of \( K \) so that the system is over damped, critical damped, under damped, and negative damped. (20 marks)

Q3:
Obtain a state space model of the system shown in figure below. Determine whether the system is completely controllable and completely observable.

![State Space Model](image)

(20 marks)

continued
Q4:
Consider the unity feedback system with an open-loop transfer function:
\[ G(s) = \frac{1}{s(s+1)} \]
Design a lead compensator \( G_c(s) \) such that the closed-loop system will satisfy the following requirements: \( K_v = 50 \), and \( \text{phase margin} = 50 \text{ deg} \) 

Q5:
A. The characteristic equation of a sampled-data system is:
\[ Z^2 - Z + 0.63 = 0 \]
Test the stability of the system using Jury’s stability criterion.
B. The closed-loop transfer function of a sample-data system is given by:
\[ \frac{Y(Z)}{R(Z)} = \frac{0.36Z + 0.26}{Z^2 - Z + 0.63} \]
Determine the damping ratio \( \zeta \) and natural frequency \( \omega_n \), where \( T = 1 \text{ sec} \).