Visvesvaraya National Institute of Technology, Nagpur

Department of Electronics and Communication Engineering

Mid Semester Examination (2023 – 2024)

Sub: (ECL415) MICROPROCESSOR AND MICROCONTROLLER	**Time:** 1.5 Hrs	**Max. Marks:** 25

1. Use Hexadecimal numbers (default) for calculations
2. Numbers (Bold and Italics) on right hand side indicates marks. [CO] indicates COs.
3. ***Assume suitable data if necessary and specify it in your code at the beginning.***
4. Default number system used in questions is hexadecimal number system unless specified otherwise.

Q. 1 [CO1, CO2] (5M)

Identify the addressing mode of instruction *MOV AL,05H[BX]*. Show the results in affected register or memory location after the execution of following group of instructions. Which flags will get affected in these codes? (BX=0002H, AX=4235H, CX=0003H, DS=5000H)

a.
```
MOV AL,05H[BX]
ADD AL, 52H
DAA
```

b.
```
MOV BX, 0005H
MOV AL, [BX]
SUB AL, CL
INC BX
MOV [BX], AL
```

DATA SEGMENT

Address	Data
50007H	52 H
50006H	9A H
50005H	7C H
50004H	65 H
50003H	54 H
50002H	21 H
50001H	4A H
50000H	3B H

Q. 2 [CO2] (5M)

Write an ALP to read the username from keyboard. If the username is "Microprocessor", then it will display "Username is valid" otherwise it will display "Invalid username".

Q. 3 [CO2] (5M)

Write a program to arrange 10 numbers in ascending order. The numbers are stored from memory location 2000H:1000H. Store the sorted numbers from 2000H:2000H.

Q.4 [CO2] (5M)

Write an ALP to solve the arithmetic equation 9*[DX] +7*[SI]+4*[DI] the result is of maximum 16-bit. Store result in [DS:BX]. Use shift and add instructions only.

Q.5 [CO1, CO4] (5M)

For an 8086-based system with following memory requirements, draw the memory interfacing diagram.

SRAM: 16KB starting from 02000H

ROM: 16KB ending at FFFFFH

The following chips are available:

SRAM – 4K×8, ROM – 4K×8

Use **74138 Decoders** and **basic gates** for chip select.

Visvesvaraya National Institute of Technology
Department of Mathematics
Mid-semester examination
Numerical Methods and Probability Theory (MAL 205)

Class : B. Tech | Batch: ECE | Semester : 3^{rd}
Date: September 2023 | Maximum Marks: 30

INSTRUCTIONS:
- *Each questions carry 5 marks.*

1. Determine p, q, and r so that the order of the iterative scheme defined by

$$x_{n+1} = px_n + \frac{qa}{x_n^2} + \frac{ra^2}{x_n^5}$$

for computing $a^{1/3}$ becomes as high as possible. For this choices of p, q, and r, indicate how the error in x_{n+1} depends on the error in x_n (of order 3). [CO1, 5 marks]

2. (a) Find a positive root of the equation

$$e^x = 1 + x + \frac{x^2}{2} + \frac{x^3}{6}e^{0.3x}$$

correct to five decimal places by using Newton-Raphson method with $x_0 = 2.5$.

(b) Using Jacobi method, find the eigenvalues of $\begin{pmatrix} 4 & 1 & 5 \\ 1 & 9 & 1 \\ 5 & 1 & 4 \end{pmatrix}$. [CO1, 2+3 marks]

3. Solve the system of equations

$$2x - y = 1, \rightarrow \quad -x + 2y - z = 0,$$
$$-y + 2z - w = 0, \rightarrow \quad -z + 2w = 1$$

using Gauss-Seidal iteration scheme with $\mathbf{x}^{(0)} = [0.5 \quad 0.5 \quad 0.5 \quad 0.5]^T$. Perform three iterations. Obtain the iteration matrix, and determine its eigenvalues and hence obtain the rate of convergence of the iterative scheme. [CO2, 5 marks]

4. Using Newton-Raphson method, solve the following system of non-linear equations

$$xy - y^3 - 1 = 0, \qquad x^2y + y - 5 = 0.$$

Take $(x_0, y_0) = (2, 3)$ as initial guess and perform two iterations. [CO1, 5 marks]

5. Using finite difference method, solve the following boundary value problem

$$y'' = xy$$
$$y(0) + y'(0) = 1, \quad y(1) = 1,$$

to find approximations for $y(0), y(0.25), y(0.5)$, and $y(0.75)$. [CO2, 5 marks]

6. (a) Using the Second order Taylor series method, with $h = 0.1$, solve the initial value problem

$$\frac{dy}{dx} = y - x, \qquad y(0) = 1,$$

to obtain an approximation for $y(0.2)$.

(b) Using Adams'-Bashforth and Adams'-Moultan predictor-corrector method, with $h = 0.1$, solve the initial value problem

$$y' = x^2(1 + y^2), \qquad y(1) = 1,$$

to obtain an approximation for $y(1.4)$. Take $y(1.1) = 1.2$, $y(1.2) = 1.49524$ and $y(1.3) = 1.961187$. Perform two iterations of the corrector. [CO2, 2+3 marks]

BT22ECE039

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics & Communication Engineering

Course Title:	**Measurements and Instrumentation**		Max. Marks:	**30**
Course Code:	**ECL – 204**		Duration:	**1.5 hour**
Semester:	**3rd**		Date:	**26th September 2023**
Exam:	**Mid Semester Examination**		Session:	**July – December 2023**

Important Instructions:
1) All questions are compulsory.
2) Assume standard values of data if not mentioned in the question.
3) Clearly state the assumptions made while answering.
4) Draw a suitable diagram/flowchart wherever necessary.
5) Indicate the important steps of reasoning/calculations.

Q1. A group of 3 students is experimenting to obtain the VI characteristics of a PN junction diode. [3] CO-2
a) What possible errors can happen while experimenting? How to avoid those errors?
b) Determine the mean and standard deviation of the observed knee voltage if the measurements are obtained as follows: [3] CO-2

Voltage	0.55	0.6	0.65	0.7	0.75	0.8	0.85
No. of observations	1	4	7	10	6	3	1

Q2. a) The only voltmeter available in a laboratory has a sensitivity of 100Ω/V with 3 scales, 50V, 150V and 300V. When connected in the circuit shown in *Figure 1* across R_x, the meter read 4.65V on its lowest scale. Calculate the value of R_x. [3] CO-1

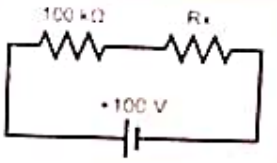


Figure 1

b) Explain CRDX. [3] CO-1

Q3. a) A series-type ohmmeter uses a 50Ω basic movement requiring an FSD current of 1mA. The internal battery voltage is 3V and the desired HSD value is 2KΩ. Calculate [3] CO-4
  a) the values of R1 and R2
  b) maximum HSD marking possible on the movement.
b) A moving coil instrument gives a full-scale deflection with a 10mA current. The resistance of the coil is 10Ω. Can this instrument be used/modified to measure 1mA for a full-scale deflection? Justify your answer. [3] CO-4

Q4. Derive the average deflection produced in an electrodynamometer used for power measurement if the applied voltage and current are represented as $e = E_m \sin(\omega t)$ and $i = I_m \sin(\omega t \pm \theta)$. [6] CO-1
Note: Draw a suitable diagram for explanation.

Q5. a) For an AC bridge, the bridge branches are as follows: [3] CO-3
arm *ab*: R_u resistors in series with L_u inductor
arm *bc*: 10Ω resistor
arm *cd*: 5Ω resistor in parallel with 1mF capacitor
arm *da*: 159Ω resistor
The supply voltage is applied at terminals *a* and *c* and the meter is connected at terminals *b* and *d*. Calculate the unknown impedance (R_u, L_u) along with the *Q* factor if the supply voltage frequency is 50Hz.
b) Justify: Use of Maxwell bridge is limited to the measurement of medium Q coil only. [3] CO-3

All the best!

VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR- 440010
Department of Electronics and Communication Engineering
(Mid Semester Examination, Sep. 2023)

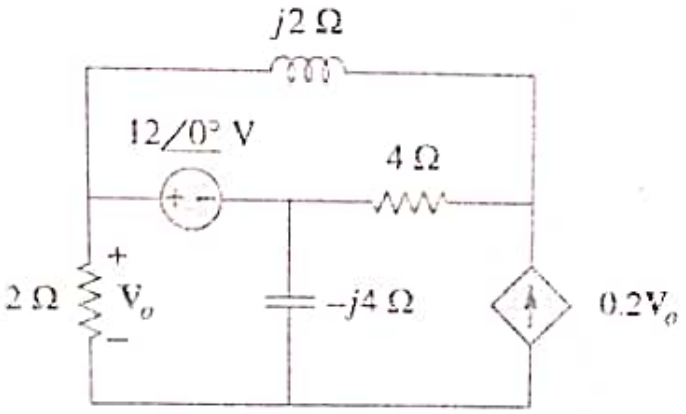
BT22ECED39

EEL209 – Linear Network Theory

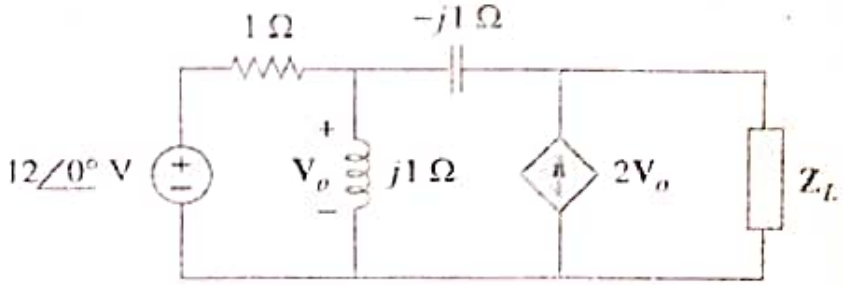
CLASS	: B. Tech	SEMESTER	: III
BRANCH	: ECE	SESSION	: W2023
TIME	: 1½ HOUR	FULL MARKS	: 25

INSTRUCTIONS:
1. The missing data if any may be assumed suitably.
2. Before attempting the questions, be sure that you have the correct question paper.

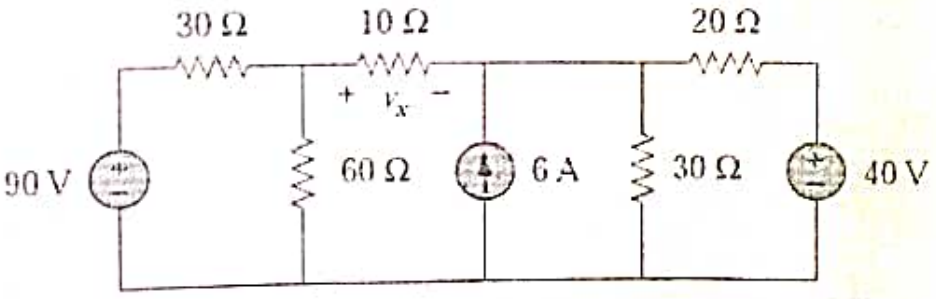
1. In the given circuit, calculate V_0 using nodal analysis. CO-1 5



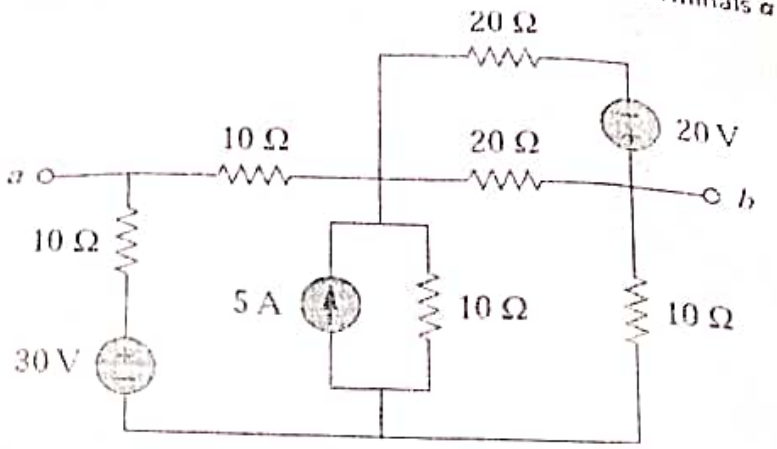
2. In the circuit shown below, find the value of Z_L that will absorb the maximum power and the value of maximum power. CO-2 6



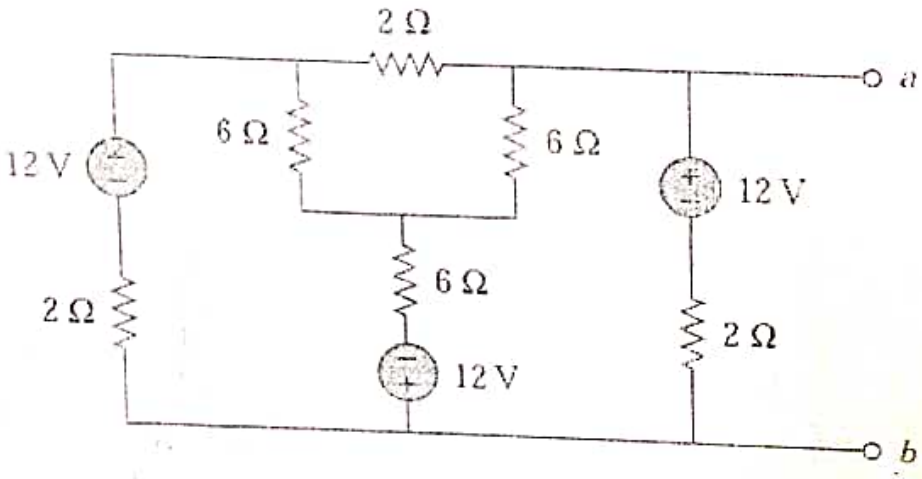
3. In the circuit shown below, find the voltage V_x. CO-1 4



4. For the shown circuit, obtain the Thevinin's equivalent between the terminals *a* and *b* CO 2 5



5. For the circuit shown below, obtain the Norton equivalent at terminals *a* and *b*. CO-2 5



*** All the Best ***

BT22ECE039

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering,
Signals and Systems Analysis (Code: ECL211)
Mid-Semestor Examination, Sept 2023

B.Tech. (ECE) Sem-3 Marks: 30

Important Instructions:

- *Plagiarism in any form is highly discouraged and attracts heavy penalty.*
- For any queries, feel free to contact the instructor/ invigilator immediately.
- Appropriate credits would be given for precision, and elaborate explanation.
- Marks are given against every question in {}.

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1. Determine if following signals satisfy the characteristics mentioned against them
   1. $x(t) = \cos^2 2\pi t$, Periodicity? Find period.
   2. $x(t) = e^{\sin t}$, Periodicity? Find period.
   3. $x[n] = \cos[0.2n]$, Periodicity? Find period.
   4. $x(t) = 10\cos(5t)\cos(10t)$, Energy or power?
   5. $x(t) = te^{-|t|}$, Energy or power?
   6. $x(t) = e^{-2t}u(t)$, Even or odd?

   [CO-1,2], $\{2 \times 6 = 12\}$.

2. The input and output of system are related as $y[n] = x[n]x[n-1] + \cos\left(3\pi n - \frac{\pi}{3}\right)$, determine whether the system is linear, time-invariant, bounded-input and bounded-output (BIBO) stability, memoryless, causal? **[CO-2]**, $\{1.5 \times 5 = 7.5\}$.

3. Give an example of system that does not satisfy any of the following: additivity, homogeneity, time-invariance, causality, stability.

   [CO-1,2], {2.5 }

4. Find value of $\int_a^b e^{-t}\delta(5t-10)dt$ when (i) $a = 3, b = 6$, (ii) $a = -3, b = 1$ (iii) $a = -3, b = 3$ and (iv) $a = -\infty, b = \infty$. **[CO-1]**, $\{4 \times 0.5 = 2\}$

5. Find impulse response of a system where output $y[n]$ is related with input $x[n]$ as $y[n] - \frac{1}{2}y[n-1] = x[n]$. **[CO-2, 3]**, {3 }.

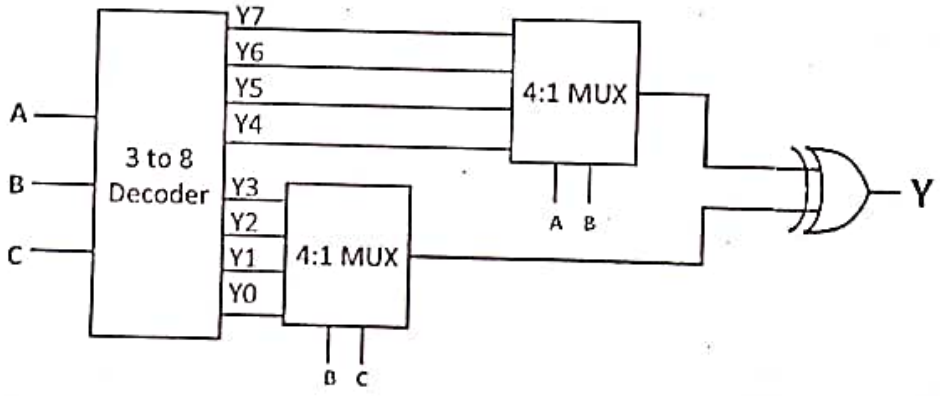
6. In an electrical engineering circuit the applied voltage $v(t)$ results into the load current $i(t)$ which are related as $\frac{di(t)}{dt} + 2i(t) = v(t)$. At any instance find $i(t)$ if $v(t) = 5e^{3t}u(t)$. **[CO-2, 3]**, {3 }.

End of exam

Visvesvaraya National Institute of Technology, Nagpur Department of Electronics and Communication Engineering	*Mid Semester Examination (2023 – 24)*
Sub: (ECL216) Digital Circuits and Hardware Design	Time: 1 Hour and 30 Minutes **Max. Marks: 30**

Important Instructions:

1. Questions carry marks as indicated in ***bold and italics.*** Use of non-programmable calculator is allowed.
2. Assume suitable data, constants if required. (Specify it before using in the answer).
3. CO refers to Course Outcome Covered in the respective question.

Que 1:	Find the output Y of the circuit as shown in figure 1 and implemented it using NAND gates only. **(CO1, CO2)**  Figure 1: Figure for question 1.	***Marks*** ***(05)***
Que 2:	The five variable function f is given in terms of minterms as follows:- $f(A, B, C, D, E) = \sum m(0,2,3,8,10,11,12,14,15,17,19,20,31)$. Using the Quine Mccluskey method minimize the function in the sum of products (SOP) form. Also, give the realization of the minimized function using basic gates only. Show all steps and all connections properly. **(CO1, CO2)**	***Marks*** ***(10)***

Que 3:	For the multiple code convertor (MCC) black box shown in figure 2, the inputs are $I_3I_2I_1I_0$ and the mode selector bits are M_1M_0. The working of the black box is as follows:-	*Marks* (15)

Sr. No.	Mode Control bits (M_1M_0)	Working Mode
1	00	Binary to Gray Code Convertor
2	01	Gray to Binary Code Convertor
3	10	Binary to Excess-3 Code convertor
4	11	Block all above three options and make the output "Valid/Invalid Output" bit as 1(high).

Design this multi code convertor (MCC) black box to convert the 4-bit input to corresponding code. To implement the circuit use basic gates only. Use of any other devices is not permitted. For $M_1M_0 = (11)_B$ only the "Valid/Invalid Output" bit is 1 (1high) for all remaining combinations it is 0 (Low). Show all the steps properly in the designing. **Hint:** I_3 is MSB; M_1 is MSB, Design the circuit as per the table indicated above.

(CO1, CO2)

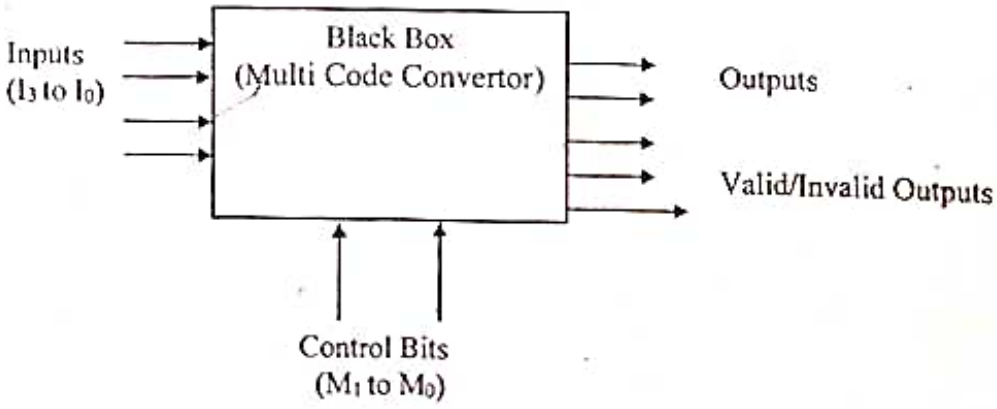


Figure 2: Figure for Question 3.

Visvesvaraya National Institute of Technology
Department of Electronics and Communication Engineering
Mid Semester Exam (Sept 2023)
Course Code – ECL207 Subject – Electronics Circuit
Time – 1.5 Hours Marks – 25 Date -29-09-2023

Q.1)

For the circuit shown in the Fig. 1 α_1= 0.98, α_2 = 0.96, V_{CC}= 24 V, R_C = 120 Ω and $I_E = 100\ mA$. Calculate the current $I_{C1}, I_{B1}, I_{E1}, I_{B2}, I_{C2}$ and I_C, the voltage V_{CE} and the ratios I_C/I_B and I_C/I_E. Neglect reverse saturation currents. [5 marks, CO1]

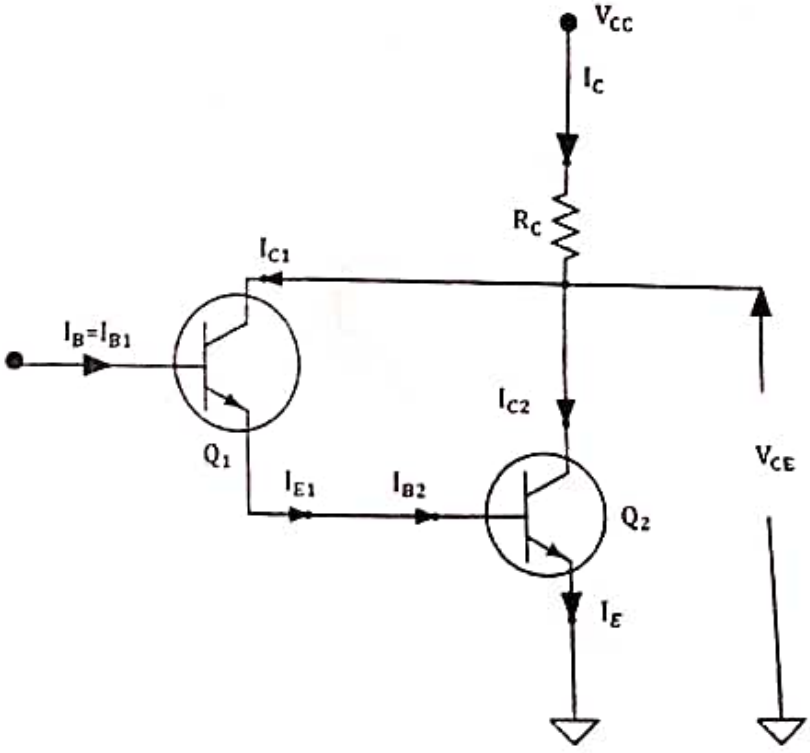


Fig. 1

Q.2)

Design a voltage divider bias circuit having stability S = 3 using a silicon transistor having β = 100. The supply voltage is 20 volts and the collector resistance is 1.5 KΩ. The quiescent point is 4 V, 8 mA. Draw the circuit diagram and the DC load line with the determined values. [5 marks, CO2]

Q3)

Calculate input impedance, output impedance, voltage gain with the help of Dynamic emitter resistance (r_e) model for a single stage BJT amplifier ($\beta = 50$) using voltage divider bias with resistance $R_1 = 100$ KΩ and $R_2 = 5$ KΩ, collector resistance $R_C = 2$ KΩ and emitter resistance $R_E = 100$ Ω and $V_{cc} = 20$ V. The coupling capacitors are 10 micro-Farads and the Emitter Bypass capacitor is 20 microfarads. [5 marks]

Draw the circuit diagram and the ac equivalent model (r_e and approximate hybrid both). [3 marks]

Calculate the voltage gain, output voltage for an input of 25 micro volt for the cascaded connection of BJT two stage amplifier. [2 marks]

[CO3]

Q4) a)

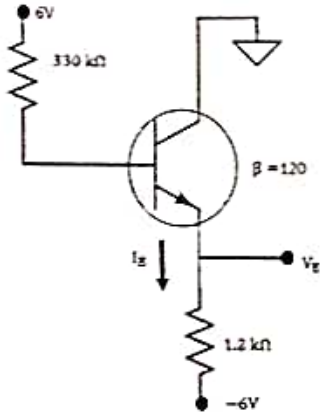


Fig. 4 a

Find V_E and I_E for the circuit shown in Fig. 4 a [2 .5 marks, CO1]

b)

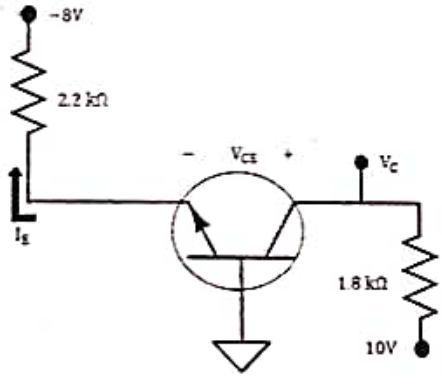


Fig 4 b

Find V_{CE} and I_E for the circuit shown in Fig. 4 b [2 .5 marks, CO2]

BT22ECE039

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics & Communication Engineering

Course Title:	**Measurements and Instrumentation**		Max. Marks:	**50**
Course Code:	**ECL – 204**		Duration:	**3 hours**
Semester:	**3rd**		Date:	**23rd November 2023**
Exam:	**End Semester Examination**		Session:	**July – December 2023**

Important Instructions:

1) All questions are compulsory.
2) Assume standard values of data if not mentioned in the question.
3) Clearly state the assumptions made while answering.
4) Draw a suitable diagram/flowchart wherever necessary.
5) Indicate the important steps of reasoning/calculations.
6) There are two parts: Part - A and Part - B. Write the answers of each part **separately** in the answer sheet

PART A

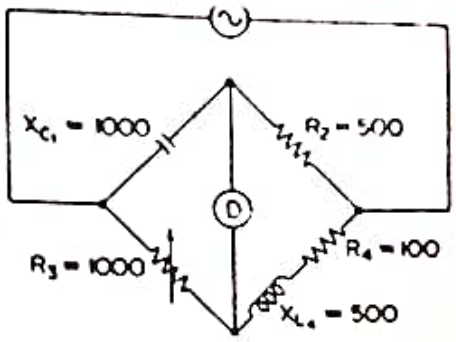
Q1. a) The following readings were observed while measuring the diameter of a metal wire: 1.34, 1.38, 1.56, 1.47, 1.42, 1.44, 1.53, 1.48, 1.40, 1.59 mm. Calculate the following: **[4] CO-2**

i. Arithmetic mean
ii. Average deviation
iii. Standard deviation
iv. Variance

b) A power transformer was tested to determine losses and efficiency. The input power was measured as 3650 W and the delivered output power was 3385 W with each reading in doubt by +/- 10W calculate (i) the percentage uncertainty in the losses of transformer (ii) the percentage uncertainty in the efficiency of transformer as determined by the difference in input and output power readings. **[4] CO-2**

c) Four capacitors are placed in parallel. The capacitor values are 36.3uF, 38.5uF, 34.002uF and 850nF with an uncertainty of one digit in the last place. What is the total capacitance? Give only the significant figures in the answer. **[2] CO-2**

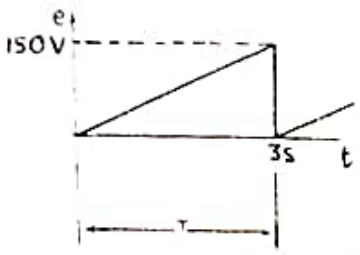
Q2. a) Determine whether the circuit shown in the figure is in complete balance. If not, show two ways in which it can be made to balance and specify numerical values for any additional components. Assume that bridge arm 4 is unknown and cannot be modified. **[4] CO-1**



b) A 50V supply is applied to two resistors of 100KΩ and 50KΩ connected in series. Two voltmeters are available for this measurement: Voltmeter 1 with a sensitivity of 1000Ω/V and Voltmeter 2 with a sensitivity of 20000Ω/V. Both meters are used in their 0-50V range. Calculate the readings on each meter and the error in each reading expressed as a percentage of the true value. **[4] CO-1**

c) What is the significance of the term double in Kelvin Double Bridge? **[2] CO-1**

PART B

Q3.	a)	Explain the working of a Frequency Counter that can generate frequency in the MHz range. Briefly explain two kinds of decade counters that can be used herein.	[4] CO-3
	b)	What is Seebeck voltage? How various elements are joined in a Thermocouple? Explain how a parasitic thermocouple is compensated in a Cu-Constantan thermocouple.	[4] CO-3
	c)	A resistance strain gage with a gage factor of 2 is fastened to a steel member subjected to a stress of 1050 Kg/cm^2. The modulus of elasticity of steel is approximately 2.1×10^6 Kg/cm^2. Calculate the fractional change in resistance due to applied stress.	[2] CO-3
Q4.	a)	(i) Draw the major blocks of a general-purpose oscilloscope and brief how horizontal and vertical deflection takes place. (ii) Explain how a pointed beam is obtained in a cathode ray tube. What is the purpose of AC and DC modes in a vertical deflection system?	[5] CO-5
	b)	(i) Explain with a neat diagram how a Delay line works in an oscilloscope. (ii) Explain in detail the working, advantages and limitations of ALT and CHOP modes in a Dual-trace oscilloscope.	[5] CO-5
Q5.	a)	In the figure shown beside, a sawtooth waveform is given with a peak of 150 V and time period of 3 seconds. If this is applied to an ***average-responding*** AC voltmeter whose scale is calibrated in terms of the RMS value of a sine wave. Calculate the **form factor** of the sawtooth waveform and the **percentage error** in meter reading. 	[4] CO-4
	b)	Explain with the functional blocks, how the decision logic works in successive approximation type digital voltmeter (DVM). Assume that DVM is of 9 bits. If the voltage to be measured is 503 volts, then explain the bit pattern of SAR for each iteration in the process of voltage measurement.	[4] CO-4
	c)	In a 6 bit DVM, if the voltage to be measured is 2.64 Volts, then find out the error in DVM reading. What is the quantizing error for a DVM?	[2] CO-4

All the best!

VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

Department of Electronics and Communication Engineering

(End Semester examination, Nov. 2023)

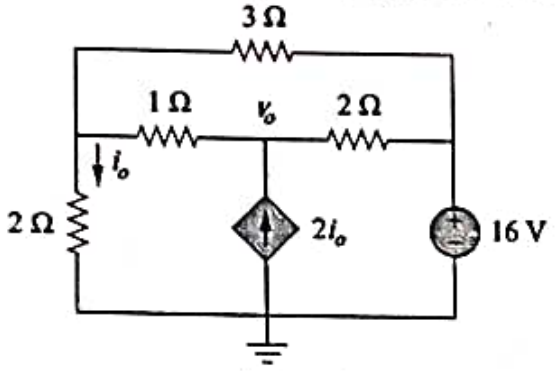
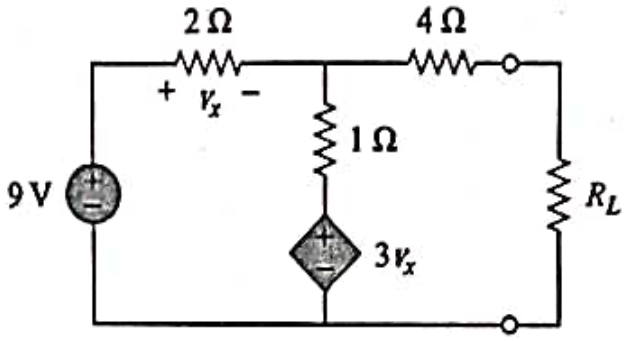
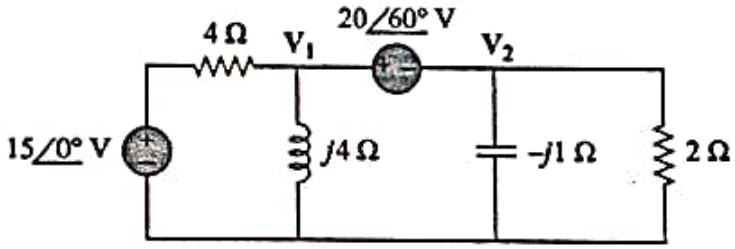
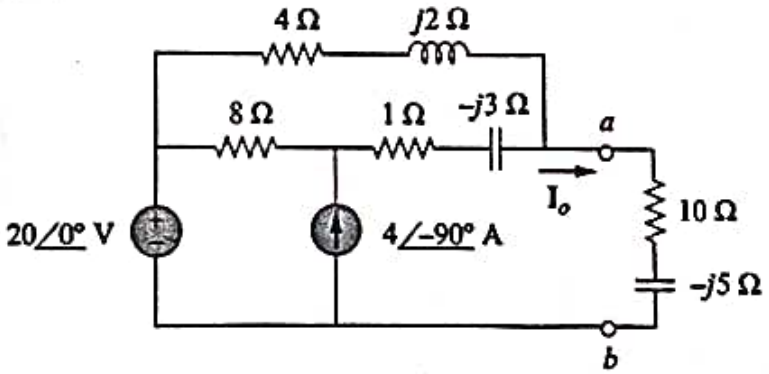
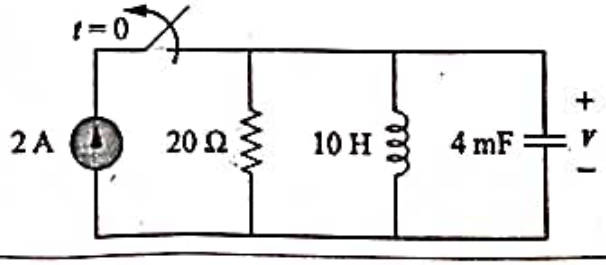
SLOT - E

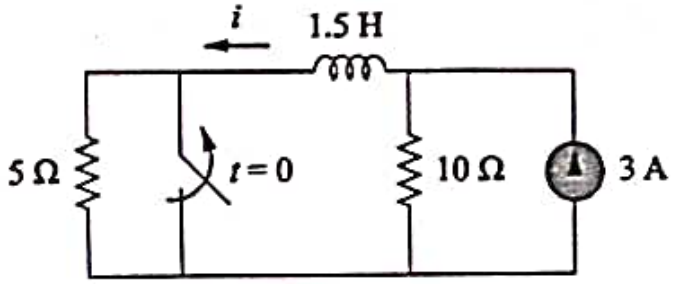
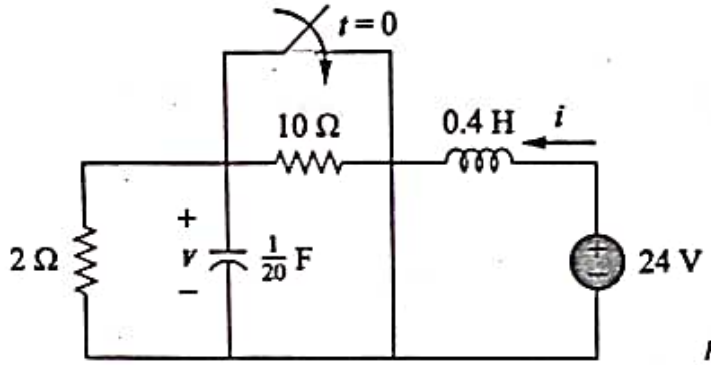
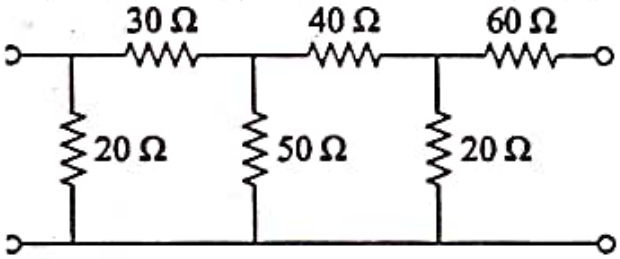
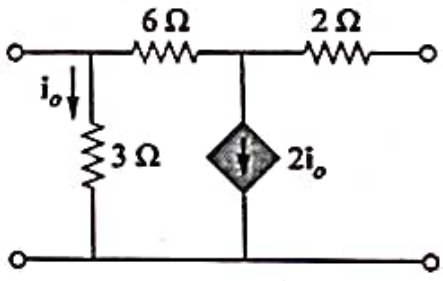
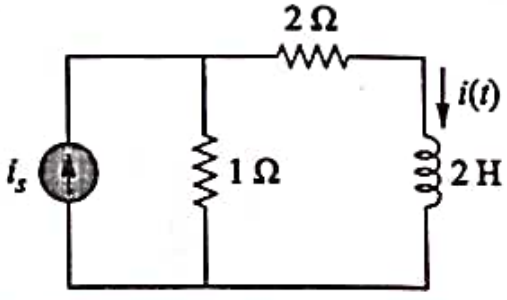
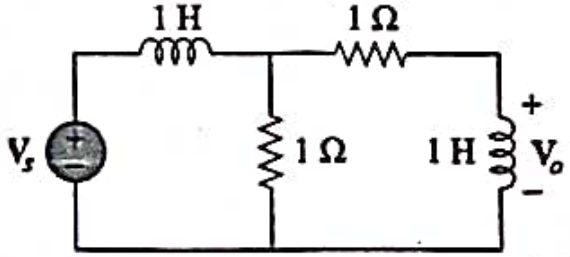
CLASS	: B. Tech	SEMESTER	: III
BRANCH	: ECE.	SESSION	: W2023
TIME	: 3 HOURs	FULL MARKS	: 55

Subject: EEL209: Linear Network Theory

INSTRUCTIONS:

1. The missing data, if any, may be assumed suitably.
2. All questions are compulsory. Q = Question Nos, M = Marks, C = Course Outcome

Q	Questions	M	C
1	(i) Determine the V_0 and i_0 in the circuit of ***Figure 1*** by using mesh analysis  ***Figure 1***  ***Figure 2***	[5]	1,2
2	Find the value of R_L that will draw the maximum power from the rest of the circuit *in* ***Figure 2.*** Calculate the maximum power	[5]	1,2
3	Calculate V_1 and V_2 in the circuit shown in ***Figure 3*** in and write the answer as sinusoidal  ***Figure 3***	[5]	2
4	Determine the Norton equivalent of the circuit in ***Figure 4*** as seen from terminals a-b. Use the equivalent to find I_0.  ***Figure 4***	[5]	1
5	Find the v(t) for t > 0 of the given circuit in ***Figure 5***  ***Figure 5***	[5]	2,3

6	The switch has been closed for long time for the circuit in ***Figure 6***. It opens at t = 0. Find i(t) for t > 0  ***Figure 6***	[5]	1,3
7	The switch was open for a long time for the circuit in ***Figure 7*** but closed at t = 0. Determine the a) $i(0^+)$, $v(0^+)$ b) $i(\infty)$, $v(\infty)$ c) $di(0^+)/dt$  ***Figure 7***	[5]	3
8	Obtain the ABCD parameters representation of the circuit in ***Figure 8***  ***Figure 8***  ***Figure 9***	[5]	1,3
9	Find the *h-parameters* for the circuit as shown ***Figure 9***	[5]	3
10	Find the *i (t)* in the circuit of ***Figure 10*** and given that $i_s(t) = 1 + \sum_{n=1}^{\infty} \frac{1}{n^2} \cos 3nt$ Amp  ***Figure 10***	[5]	1,3
11	Find the type of filter and calculate the corner frequency for the circuit as shown in ***Figure 11***  ***Figure 11***	[5]	2

*****

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
Sem-End, Nov 2023

Time: 03 Hours | *B.Tech. (ECE) Sem-3* | Marks: 60

Important Instructions:

- For any queries, feel free to contact the instructor/ invigilator immediately.
- Appropriate credits would be given for precision, and elaborate explanation.
- Assume suitable data wherever necessary.

---

1. Consider a signal $x(t) = 1$, for $-1 \leq t \leq 1$. Analytically step-by-step obtain the expression for the output $y(t)$ of an LTI whose input is $x(t)$ and the impulse response $h(t) = \frac{x(t)}{2}$. [10]

2. With respect to Q1,
   (a) Obtain the expressions and neatly sketch the Fourier transforms of the input and the impulse response. [5]
   (b) Verify the convolution property of the Fourier transform specifically with respect to the expressions obtained Q1 (a). [5]

3. With respect to Q1,
   (a) Neatly sketch and label the magnitude of the Fourier transform only between the first zero-crossing on $\pm\Omega$. [5]
   (b) With respect to Q2(a), neatly sketch and label the magnitude of the Fourier transform after sampling exactly at $F_s = F_m$, $F_s = 2F_m$, $F_s = 3F_m$. [5]

4. With respect to Q1,
   (a) Obtain the expressions for the Laplace transforms of the input and the impulse response. [5]
   (b) Verify the convolution property of the Laplace transform specifically with respect to the expressions obtained in the previous part. [5]

5. With respect to Q1,
   (a) Neatly sketch and label the samples of $x(t), h(t)$ and $y(t)$ at every integer of t and obtain respective z-transforms. [5]
   (b) Verify the convolution property of z-transorm specifically with respect to $x[n], h[n]$ and $y[n]$ obtained in Q5(a) [5]
   (c) Ignore the constant (DC) value (if any). Neatly sketch and label the Fourier transform of $y[n]$ from the expression obtained in Q5(a) only between the first zero-crossing on $\pm\omega$. Further, approximately sketch and label the Fourier transform obtained after sampling by 2, upsampling by 3, and upsampling by 3 then downsampling by 2. [10]

End of exam

BT22ECE039

Visvesvaraya National Institute of Technology, Nagpur
Dept. of Electronics and Communication Engineering
Electronic Devices (ECL-257)
B.Tech. Semester III

Slot G: Time 3 Hour
Date: Nov. 29, 2023
End Semester
Maximum Marks: 55

Assume any missing data and mention it

Q.1: Given silicon transistor as shown below is biased by current source and having beta value of 99 calculate its base and collector current? Also show that whether BJT is in Active or in Saturation Mode? **[CO 1 and 2] [5 Marks]**

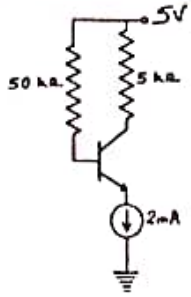


Figure for Question No. 01

Q.2: A circuit employing a transistor and a Zener diode is to supply of 2A. at a constant voltage of 4V. If the supply voltage is 12Vand it varies by ±2V. Calculate the value of R_B as in the figure below, Assume, β=50, V_{BE}=0.5V and $I_{Z\,(max)}$=10mA **[CO 1 and 2] [5 Marks]**

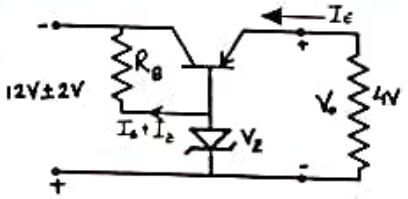


Figure for Question No. 02

Q.3: For the circuit shown below, the transistor Q_1 and Q_2. Operated in the active region with $V_{BE1}=V_{BE2}$= 0.7, β_1=100, β_2=50. The reverse saturation current may be neglected. Find the currents I_{B2}, I_1, I_{C2}, I_{B1}, I_{C1} and I_{E1} **[CO1 & 2]. [5 Marks]**

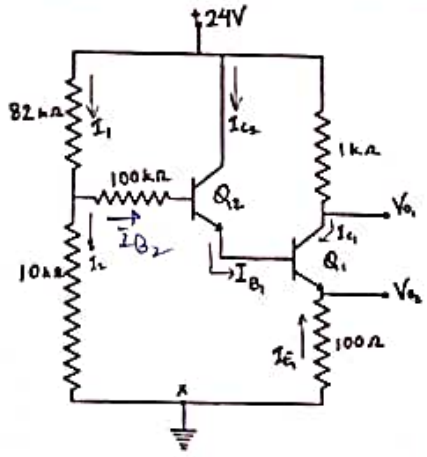


Figure for Question No. 03

Visvesvaraya National Institute of Technology, Nagpur
Dept. of Electronics and Communication Engineering
Electronic Devices (ECL-257)
B.Tech. Semester III

Slot G: Time 3 Hour
Date: Nov. 29, 2023
End Semester
Maximum Marks: 55

Assume any missing data and mention it

Q.4: Consider the MOSFET circuit with source resistance of 0.5 kΩ as shown in the figure below, ($k=2mA/V^2$) assume $V_t=1V$. Determine the drain voltage and also justify the mode of operation in which MOSFET belongs? **[CO4 & CO5]. [5 Marks]**

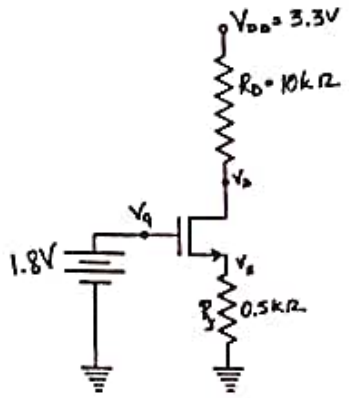


Figure for Question No. 04

Q.5: Find Lower Cutoff Frequency for the mentioned below BJT **[CO 1,2,3] [7.5 Marks]**

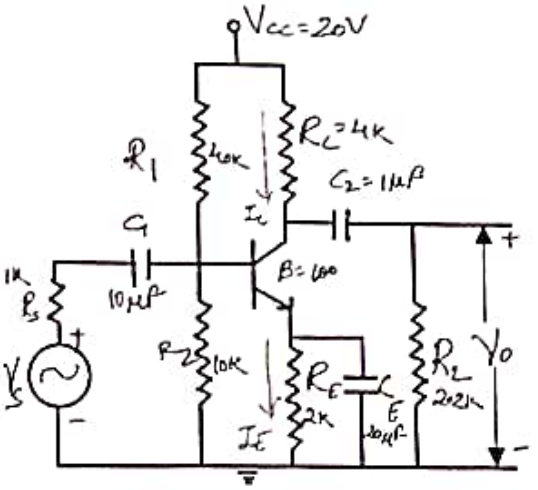


Figure for Question No. 05

Q.6: For the circuit of Fig.6, determine (using appropriate approximations) (Emitter un-bypassed). : **[CO 1 and 2] (5 marks)**

(a) r_e (b) Z_i (c) Z_o (d) A_v

Visvesvaraya National Institute of Technology, Nagpur
Dept. of Electronics and Communication Engineering
Electronic Devices (ECL-257)
B.Tech. Semester III

Slot G: Time 3 Hour
Date: Nov. 29, 2023
End Semester
Maximum Marks: 55

Assume any missing data and mention it

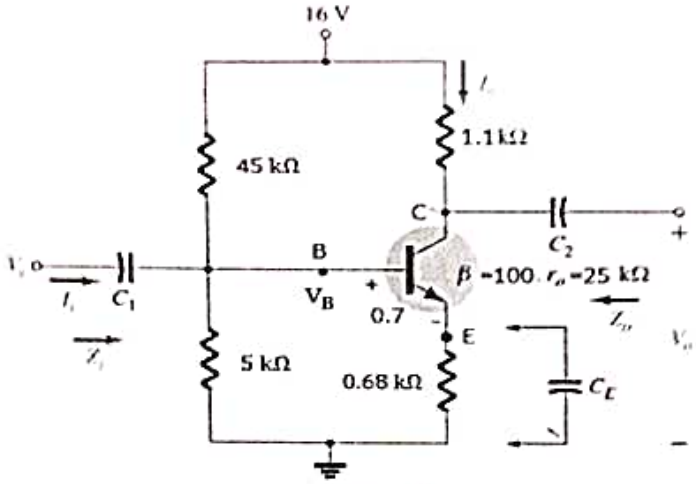


Figure. 6

Q7. Repeat Q6 with C_E in place. (Emitter is bypassed using capacitor C_E) **[CO 3]** (3.5 marks)

Q8. For the emitter-follower circuit of Fig.8, determine:
(a) r_e (b) Z_i (c) Z_o (d) A_v (e) A_i **[CO 4]** (5 marks)

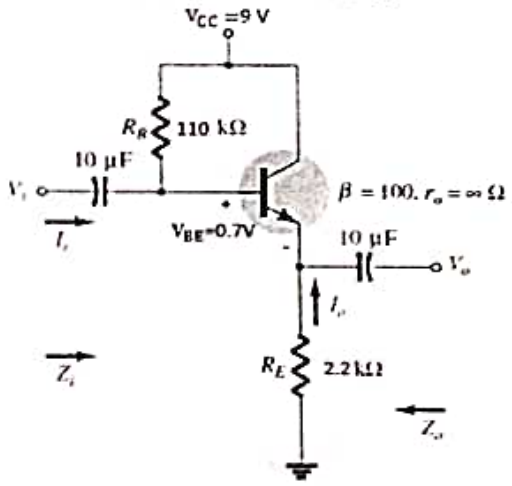


Figure. 8

Q9. The circuit of Fig.9 was analyzed, resulting in $V_{GS_Q} = 0.3\,V$ and $I_{D_Q} = 7.5\,mA$.

[CO5] (6 marks)
(a) Determine g_m and compare to g_{m0}.
(b) Sketch the ac equivalent network for Fig. 9
(c) Find Z_i.
(d) Calculate Z_o.
(e) Find A_v

Visvesvaraya National Institute of Technology, Nagpur
Dept. of Electronics and Communication Engineering
Electronic Devices (ECL-257)
B.Tech. Semester III

Slot G: Time 3 Hour
Date: Nov. 29, 2023
End Semester
Maximum Marks: 55

Assume any missing data and mention it

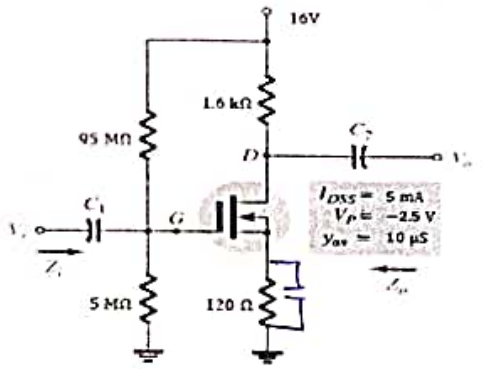


Figure. 9

Q10. Determine the levels of V_D and V_{GS} for the circuit of Fig.10.

[CO 3] (5 marks)

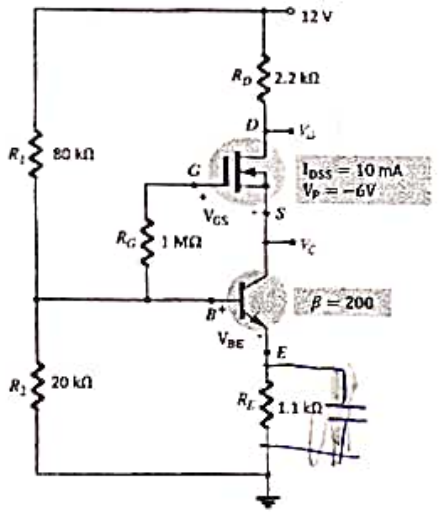


Figure. 10

Q11. Calculate the input power, output power, and efficiency of the amplifier circuit in Fig.11 for an input voltage that results in a base current of 10 mA peak. **[CO 4]** (3 marks)

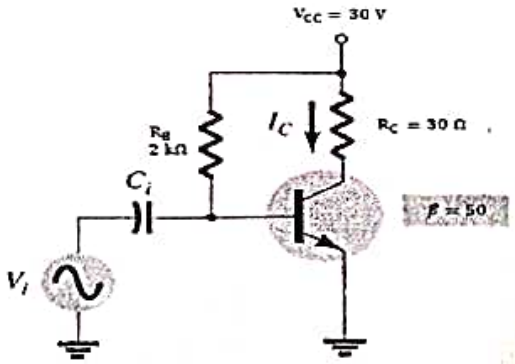


Figure. 11

CENTER FOR VLSI AND NANOTECHNOLOGY

Introduction to VLSI Design

Time: 1:30Hrs | Feb 2024 | Max.Marks: 25

INSTRUCTIONS TO THE CANDIDATES

1. Assume suitable data whenever necessary and write your assumptions clearly.

Que.1. In a SOC to be fabricated with 180 nm technology, a 100 Ohm resistor is to be designed in one of analogue module with polysilicon (silicided), which has got the sheet resistance of 4 ohm/sq. Sketch the layout of this resistor with the justification of its size and shape. Estimate the parasitic elements associated with this resistor. **(10)**

Que.2. What are the important components of any electronic systems. **(5)**

Que.3 Draw the circuit of DRAM cell. Consider a cell that has a storage Cs, Vdd=3.0V and Vth is 0.5V. The leakage current from the storage capacitor is estimated to be 1pA. Assuming that 2nm SiO_2 layer is used as dielectric, design Cs for this process assuming that the refresh-time is 64ms. Redesign the capacitor if 2nm HfO_2 used as dielectric. **(10)**

--END—

BT22ECE039

Department of Electronics and Communication Engineering

Mid Semester Examination, Jan-May 2023-2024

ECL304 - Digital Signal Processing, Slot C

Date: Feb 22, 2023 (Thursday) **Time:** 01 hour 30 minutes **Max. Marks:** 30

Note: Answer all questions and assume missing data, if any.

1. a) A continuous-time signal $x_c(t)$ is sampled by an A/D converter to obtain the sequence $x(n)$. It is processed by a digital filter $h(n) = 0.8^n u(n)$ to obtain the sequence $y(n)$, which is further reconstructed using an ideal D/A converter to obtain the continuous-time output $y_c(t)$. The sampling frequency of A/D and D/A converters is 100 sampling intervals per second. If $x_c(t) = 2cos(40\pi t + \pi/3)$, what is the digital frequency ω_0 in $x(n)$? **[02 Marks, CO1]**

   b) A complex continuous-time signal $x(t)$ has the Fourier transform shown in Figure 1. This signal is sampled to produce the sequence $x_s(n)$.
   (i) What is the lowest sampling frequency (Ω_s), required to avoid aliasing?
   (ii) Sketch $X_s(\Omega)$ and $X_s(\omega)$ for a no-aliasing condition.
   (iii) Sketch $X_s(\Omega)$ and $X_s(\omega)$ for an aliasing condition.
   (iv) Draw the block diagram of a system that can recover $x(t)$ from $x_s(n)$ if there is no aliasing. Sketch the spectrum of any filter used in your diagram. **[01+03+03+01=08 Marks, CO1]**

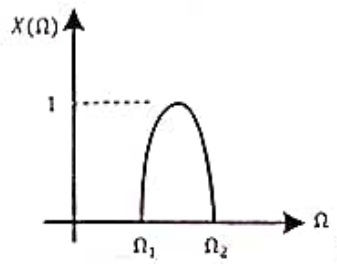


Figure 1

2. a) Using overlap-save method, find the output of a filter with impulse response $h(k)$ and the input $p(k)$ shown in Figure 2 below.

   b) Verify the linear convolution of the input sequence with the impulse response of filter gives the same output as that found by the overlap-save algorithm (use mathematical formulation only). **[03+03=06 Marks, CO2]**

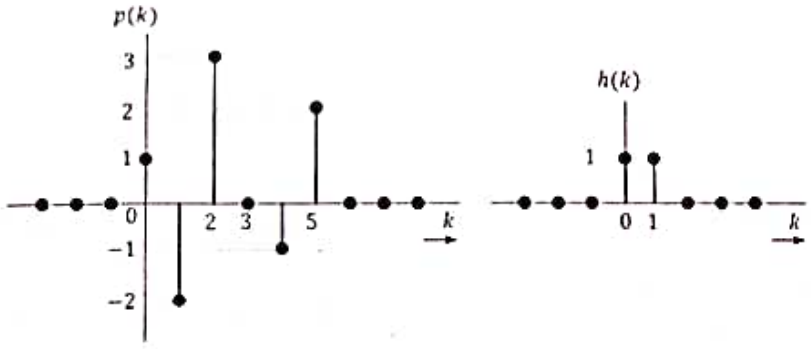


Figure 2

3. a) Draw the signal flow graph [diagram using the butterflies] for the 8-point radix-2 decimation in frequency (DIF) algorithm and clearly write the equations for inputs and outputs at each stage. Compute the FFT of the following sequence using the equations of the 8-point radix-2

Please turn over...

DIF algorithm.

$$x[n] = \begin{cases} 1; & n = 0, 2, 4, 6 \\ 0; & n = 1, 3, 5, 7 \end{cases}$$

b) Find out the number of real computations you had to perform for computing FFT of $x[n]$ using radix-2 DIF algorithm. If you would have used direct DFT formula, how many computations could be saved? **[06+03+1.5+1.5=12 Marks, CO2]**

4. Assume $X_1[k]$ is the 8 point DFT of the following sequence

$$x_1[n] = \begin{cases} 1; & 0 \leq n \leq 3 \\ 0; & 4 \leq n \leq 7 \end{cases}$$

Find out the DFT of the following sequence in terms of $X_1[k]$

$$x_2[n] = \begin{cases} 0; & 0 \leq n \leq 1 \\ 1; & 2 \leq n \leq 5 \\ 0; & 6 \leq n \leq 7 \end{cases}$$

[02 Marks, CO2]

**********End of Question Paper**********

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics & Communication Engineering
Mid Sessional Exam February 2024

Branch: 4th SEM B. Tech Electronics & Communication Engineering

Time: 1.5hr Subject: Analog Communication (ECL301) Max. Marks 30

Q.1 Choose the proper alternatives: $1 \times 8 = 8$ (CO1)

A) For which of the following modulation scheme, an increase in modulation index leads to increase in the transmitted bandwidth
a. PM b. FM c Both FM and PM d. AM

B) Envelope detector is ___
a. Coherent detector b. Synchronous detector c. Asynchronous detector d. Product demodulator

C) The amount of frequency deviation in FM signal depends on
a. modulating frequency b. carrier frequency
c. amplitude of the modulating signal d. transmitter amplifier

D) Calculate the modulation index in an FM signal for modulating frequency of 250 Hz and frequency deviation is 5KHz
a. 35 b. 50 c. 20 d. 57

E) The modulation index of an AM wave is changed from 0 to 1. The transmitted Power is
a. unchanged b. halved c. doubled d. increased by 50 %

F) Hilbert transform used in
a. DSB modulation b. SSB modulation.
c. DSB demodulation d. SSB demodulation

G) Switch modulator is a
a. double balance modulator b. single balance modulator
c. rectifier detector d. balance modulator

H) What is the ratio of sideband power to total power at 100 percent modulation
a. 1:3 b. 1:2 c. 2:3 d. None of the above

Q.2 a) The antenna current of an AM transmitter is 8A when only the carrier is sent, but it increases to 8.93A when the carrier is modulated by a single sine wave. Find the percentage of modulation. Determine the antenna current when the percentage of modulation changes to 0.8

b) For the message signal of $m(t) = 15\cos(60\pi t)$ and carrier signal of $c(t) = 60\cos(500\pi t)$. Following the AM modulation scheme, draw the spectrum of the modulated signal. Find the carrier and side band powers, modulation index and transmission bandwidth

c) A transmitter radiates 9KW with the carrier unmodulated and 10.125KW when the carrier is sinusoidally modulated. Calculate the modulation index. If another sine

wave corresponding to 40% modulation is transmitted simultaneously, determine the total modulation index.

21312 7 (CO2&CO3)

Q.3 a) How a SSB & VSB signal can be modulated and demodulated?

b) What do you mean by carrier acquisition in suppressed carrier AM?

c) What do you mean by QAM? How it works?

6+2+2=10 (CO4 & CO5)

Q4 a) In an FM system, when the audio frequency (AF) is 400 Hz and the AF voltage is 5.6 V, the deviation is 9.6 KHz. If the AF voltage is now increased to 14.8 V, what is the new deviation? If the AF voltage is raised to 40 V while the AF is dropped to 200 Hz, what is the deviation? Find the modulation index in each case.

b) How NBFM can be generated?

2.5+2.5=5 (CO5)

Visvesvaraya National Institute of Technology, Nagpur
Department of Mathematics
B. Tech. (4th Semester, ECE) S-24,
Linear Algebra and Partial Differential Equations(MAL-210),
Mid Semester Exmination

Time: 1.5 hours **Max Marks: 30**

Note: **All questions are compulsory. Calculator is not allowed.**

1. Let $T : \mathbb{R}^3 \to \mathbb{R}^3$ be defined by

$$T(x, y, z) = (4x + y - z,\ 2x + 5y - 2z,\ x + y + 2z).$$

Is T diagonalizable? If yes, find the basis of $\mathbb{R}^3$ that diagonalizes T, and find its diagonal representation D. [CO1, 5]

2. State and prove the Rank-Nullity theorem. [CO1, 5]

3. Let $T : M_2(\mathbb{R}) \longrightarrow P_2[x]$ defined by

$$T\begin{bmatrix} a & b \\ c & d \end{bmatrix} = (a + b) + (c + 2d)x + (2c + 4d)x^2.$$

Show that T is linear. Find a basis and the dimension of $\text{Ker}(T)$ and $\text{Im}(T)$. [CO1, 5]

4. Suppose $v_1, v_2, v_3, \ldots v_n$ are nonzero eigenvectors of a linear operator T belonging to distinct eigenvalues $\lambda_1, \lambda_2, \lambda_3, \ldots, \lambda_n$. Prove that $v_1, v_2, v_3, \ldots v_n$ are linearly independent. [CO2, 5]

5. Using the Gram-Schmidt orthogonalization process, find an orthonormal basis for the subspace U of $\mathbb{R}^4$ spanned by $V_1 = (1, 1, 1, 1), V_2 = (1, 1, 2, 4), V_3 = (1, 2, -4, -3)$. [CO2, 5]

6. Let $T : \mathbb{R}^3 \to \mathbb{R}^2$ be the linear map defined by

$$T(x, y, z) = (3x + 2y - 4z,\ x - 5y + 3z).$$

Consider the following bases of $\mathbb{R}^3$ and $\mathbb{R}^2$:

$$S = \{v_1, v_2, v_3\} = \{(1, 1, 1), (1, 1, 0), (1, 0, 0)\}$$

and

$$S' = \{w_1, w_2\} = \{(1, 3), (2, 5)\}.$$

Find the matrix $[T]_{S,S'}$ representing T relative to the bases S and S'. Also, verify that for any vector u in $\mathbb{R}^3$, $[T]_{S,S'}[u]_S = [T(u)]_{S'}$. [CO2, 5]

Department of Electronics & Communication Engineering, VNIT, Nagpur.

Mid sem Exam February 2024

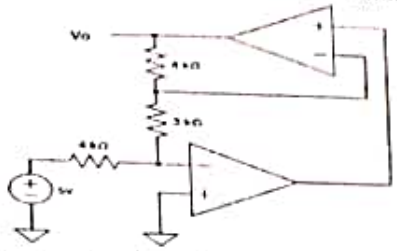
Fourth Sem B.Tech (Electronics & Communication)

Analog circuit design (ECL308), Slot- G

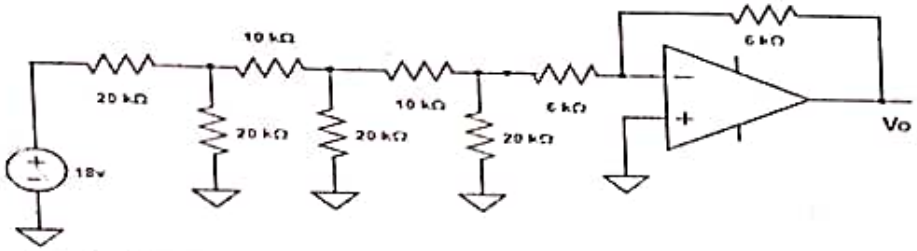
Time: 1.5 Hrs

Marks: 25

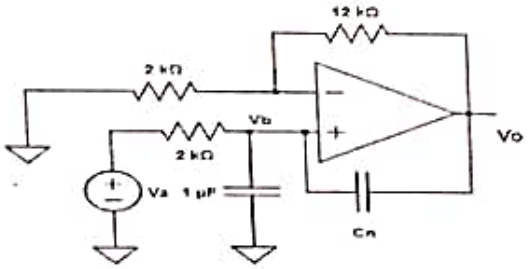
Q.1) Assuming ideal op-amp, find Vo for the following circuit. (CO1 ,02)



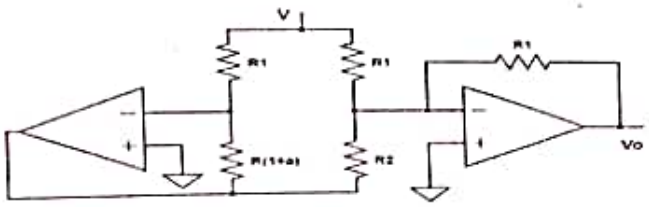
Q.2) Find Vo. Assume Vcc= ± 10 V (CO1 ,02)



Q.3) For the following circuit, find Cn if Va=Vb. (CO1 ,02)



Q.4) Find Vo for the following circuit. (CO1 ,02)



Q.5) For a practical integrator with R1=120kΩ. Rf=1.2MΩ, Cf=10nF, Evaluate the following

a) Determine the frequency above which integration will take place

b) Determine DC gain

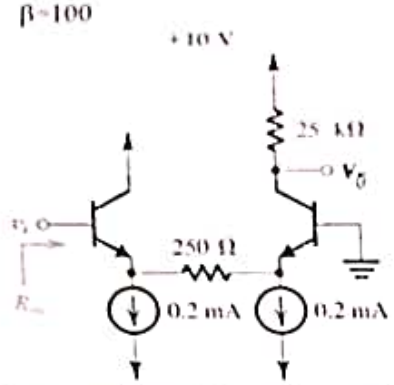
c) Find the peak output voltage for sine wave input with 5v peak and 10kHz frequency. (CO4 ,02)

Q.6) A BJT differential amplifier uses a 300μA bias current. What is the value of gm of each device? If β=150, what is the differential input resistance? (CO1,CO4,02)

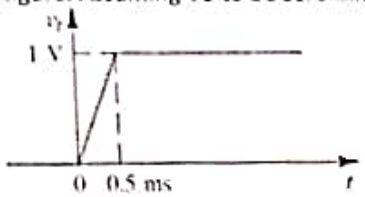
Q.7) An op-amp has gain B.W product of 20 MHz is operated with a closed loop gain of 100. What 3 dB B.W. results? (CO1 ,02)

Q.8) Find the voltage gain and input impedence for the differential amplifier shown below. Assume

β=100 (CO1, 02)



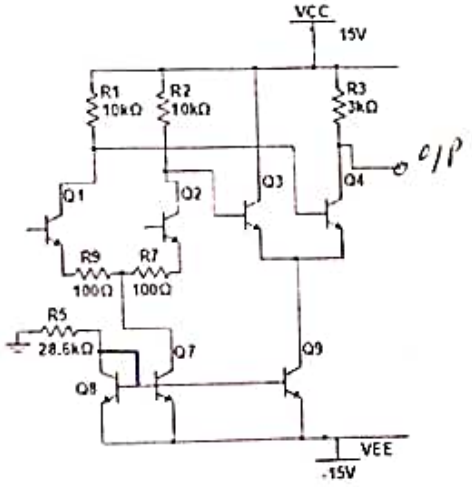
Q.9) An op-amp differentiator with 1-ms time constant is driven by the rate-controlled step shown in figure. Assuming Vo to be zero initially, sketch and label its waveform. (CO4, 02)



Q.10) An op-amp has a slew rate of 2V/μs.What is the maximum frequency of an output sinusoid of peak value5V at which distortion sets in due to the slew rate limitation? (CO1 ,02)

Q.11) An operational amplifier circuit with a closed-loop gain of 100 has a common mode output of 5μv when the common mode input is 5mv. Determine the common mode rejection ratio. (CO1, 02)

Q.12) Determine the overall gain for the following circuit. Assume β=100 (CO1, 03)



BT22ECE039
SAURAV AVACHAT

विश्वेशवरय्या राष्ट्रीय प्रौद्योगिकी संस्थान, नागपूर-440010
इलेक्ट्रॉनिक्स और संचार अभियांत्रिकी विभाग
Electromagnetic Field (ECL-305)
B.Tech. Semester IV
Assume any missing data and mention it

Slot H: Time 1.5 hour
Date: Feb.27, 2024
Mid. Semester Exam
Maximum Marks: 30

Q.1: Determine the amount of Energy required to assemble a uniform sphere of charge of radius 'b' and volume charge density 'ρ_v' **[CO 2][4 Marks]**

Q.2: A cylindrical capacitor as shown below, consists of an inner conductor of radius 'a' and an outer conductor whose inner radius is 'b'. The space between the conductors is filled with a dielectric of permittivity 'ε' and the length of capacitor is 'L'. Determine the capacitance of this capacitor. **[CO 2][4 Marks]**

Q.3: Calculate Electric Field at an height of 'h' from the circular disk of radius 'b' and a uniform surface charge density of 'σ_s' using Potential function. **[CO 2][4 Marks]**

Q.4: An infinite thread of uniform charge density 'λ' per unit length, and has configuration as shown below consider the curvature with radius 'R' and is considerably less than length of the thread, Find magnitude and direction of Electric field at point 'O' **[CO 2][4 Marks]**

Q.5: Find the angle at which line x=y=2z, intersects the ellipsoid $x^2+y^2+2z^2=10$ **[CO 1][3 Marks]**

Q.6: Check the divergence theorem for the function and using as your volume of one octant(along positive unit directions) of sphere of radius 'R' **[CO 1][3 Marks]**

$$v = r^2 \cos\theta \ \hat{r} + r^2 \cos\varphi \ \hat{\theta} - r^2 \cos\theta \sin\varphi \ \hat{\varphi}$$

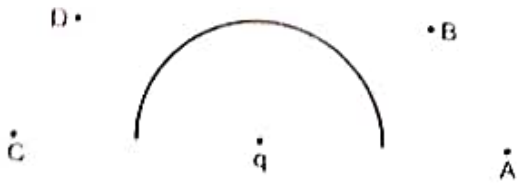
Q.7: Check Stokes' theorem using the function $v = ay\,\hat{x} + bx\,\hat{y}$ (a and b are constants) and the circular path of radius 'R', centered at the origin in the xy plane. **[CO1 3 Marks]**

Q.8: Choose the correct answer **[CO2 5 Marks (1 each)]**

i. The Electric field and Electric Potential at a point are E and V respectively.
   a. If E=0, V must be **Zero.**
   b. If V=0, E must be **Zero.**
   c. If $E \neq 0$, V cannot be **Zero.**
   d. If V≠0, E cannot be **Zero.**

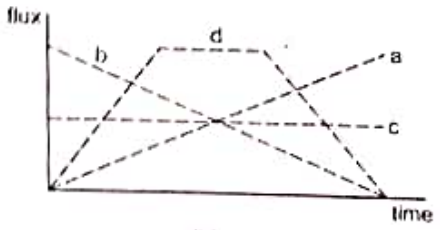
ii. The figure shows a charge **'q'** placed at the center of a hemisphere, A second charge **'Q'** is placed at one of the locations A, B, C, D. In which position(s) of second charge, the flux of electric field through the hemisphere remains unchanged.

a. A
b. B
c. C
d. D



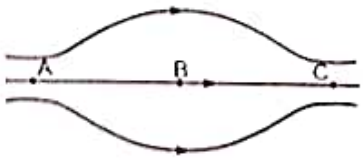
iii. Figure shows an imaginary cube of edge **L/2.** A uniformly charged rod of length **'L' moves** towards left at a small but constant speed **'v'**. At t=0, the left end just touched the centre of the face of the cuve opposite to it. Which of the graphs shown below represents the flux of the electric field through the cube as the rod goes through it.

(a)



(b)

Iv. Figure shows some of the Electric Field lines corresponding to an Electric Field. The figure suggests that



a. $E_A > E_B > E_C$
b. $E_A = E_B = E_C$
c. $E_A = E_C > E_B$
d. $E_A = E_C <$ sssE_B

v. Which statement is correct

a. The Total charge of the universe is constant
b. The total positive charge of the universe is constant
c. The total negative charge of the universe is constant
d. The total number of charged particles in universe is constants

BT22ECE031

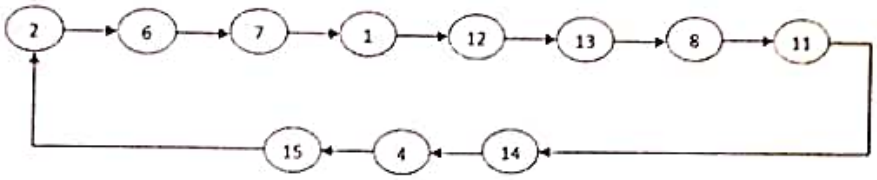
Visvesvaraya National Institute of Technology, Nagpur

Department of Electronics and Communication Engineering

End Semester Examination (2023 – 2024)

Sub: (ECL216) Digital Circuits and Hardware Design	Time: 3.00 Hrs	Max. Marks: 50

1. Use decimal numbers (default) for calculations
2. Numbers (Bold and Italics) on right hand side indicates marks. [CO] indicates COs.
3. ***Assume suitable data if necessary and specify it in your design at the beginning.***
4. Default number system used in questions is decimal number system unless specified otherwise.

Q. 1	Find a minimum sum-of-products expression for the following function: f(A, B, C, D, E) =∑m (0, 1, 3, 8, 9, 13, 14, 15, 16, 17, 19, 24, 25, 27, 31) using Quine Mc-cluskey method. Obtain all possible minimal expressions.	[CO1, CO2] ***(10M)***
Q. 2	Design a FSM to detect the sequence **1010** in an incoming bit stream. When the sequence is detected, the FSM produces an output logic high else the output always remains active low. FSM designing steps are to be followed with memory element designing using D flip flops. Show all steps properly. Overlapping of sequence is permitted.	[CO2, CO3] ***(10M)***
Q. 3	Design a synchronous counter using T flip flops which has the state transitions as given below.  All odd numbered invalid states must jump to state 6 while all even number invalid states must jump to state 11. Draw the full sate diagram and design the circuit with proper details.	[CO1, CO2, CO3] ***(10M)***
Q. 4	a) Write Verilog code for 4:1 MUX using a) Behavioural and b) Gate level modelling. b) Write Verilog code for the function f(P, Q, R, S) = Σm(0,2,4,6,7,8,10,12,13,15) using Dataflow modelling.	[CO3, CO5] ***(6M)*** [CO3, CO5] ***(4M)***
Q. 5	Write Verilog code 8-bit adder which adds $A_0A_1A_2A_3A_4A_5A_6A_7$ with $B_0B_1B_2B_3B_4B_5B_6B_7$ Use Full adder as instantiation component using gate level modelling.	[CO4, CO5] ***(10M)***

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Visvesvaraya National Institute of Technology
Department of Mathematics
End-Semester examination
Numerical Methods and Probability Theory (MAL 205)

Class : B. Tech | Batch: ECE | Semester : 3rd
Date: November 22, 2023 | Maximum Marks: 50

INSTRUCTIONS:

- *Each questions carry 10 marks.*

1. (a) Suppose that a trainee soldier shoots a target in an independent fashion. If the probability that he hits the target in any shot is 0.4. What is the probability that it takes him (i) more than 5 shots, (ii) an odd number of shots to hit the target first time? What is the expected number and variance of shots required to hit the target first time? [CO4, 3 Marks]

   (b) Using Normal distribution find the probability that 100 tosses of a coin will result exactly 50 heads. Compare this results with the exact result. [CO4, 3 Marks]

   (c)(i) Let the probability density function for a continuous random variable X be given by

$$f(x) = \begin{cases} c(4x - 2x^2), & \text{if } 0 < x < 2, \\ 0, & \text{otherwise} \end{cases}.$$

   Find the value of (i) c, (ii) $P(0 < X < 2)$, (iii) $P(\frac{1}{2} < X < \frac{3}{2})$, and (iv) $P(X > 3)$.

   (ii) Suppose that X is a random variable with mean 10 and variance 15. Use Chebyshev's inequality to find $P(5 < X < 15)$? [CO3, 4 Marks]

2. (a)If X and Y are independent Poisson random variates such that $P(X = 1) = P(X = 2)$ and $P(Y = 2) = P(Y = 3)$. Find, the variance of $X - 2Y$. [CO4, 3 Marks]

   (b) Given

$$f(x, y) = \begin{cases} e^{-(x+y)}, & \text{if } 0 \le x < \infty, 0 \le y < \infty, \\ 0, & \text{otherwise.} \end{cases}.$$

   Are the random variable X and Y independent? Find (i) $P(X > 1)$ (ii) $P(X < Y \mid X < 2Y)$ (iii) $P(1 < X + Y < 2)$. [CO3, 3 marks]

   (c) The Joint PDF of X and Y is

$$f(x, y) = \begin{cases} k\left(x^2 + y^2\right), & \text{if } x^2 + y^2 < 1, \\ 0, & \text{if } x^2 + y^2 \ge 1 \end{cases}.$$

   Find k and the marginal and conditional distributions of X and Y. [CO3, 4 marks]

3. (a) On a multiple choice (single correct) exam with four possible answers for each of the 60 questions, what is the probability that a student would get between 11 to 14 correct answers just by guessing? Use Binomial and Poisson distributions and then compare the results. [CO4, 3 Marks]

   (b) Let X be a normal variate with mean 42 and standard deviation 4. Find the probability that a value taken by X is (i) less than 50, (ii) between 43 and 46, and (iii)

greater than 42. [CO4, 3 Marks]

(c) The probability function of the random variable X follows the probability law

$$p(x) = \frac{1}{2\theta}\exp\left(\frac{-|x-\theta|}{\theta}\right), -\infty < x < \infty$$

Find M.G.F of X. Hence or otherwise find $E(X)$ and $V(X)$. [CO4, 4 marks]

4. (a) A man with n keys wants to open his door and tries the keys independently and at random. Find the mean and variance of the number of trials required to open the door. (i) If unsuccessful keys are not eliminated from further selection and (ii) If they are eliminated. [CO4, 5 marks]

(b) If $\{X(t) = A\cos\lambda t + B\sin\lambda t; t \geq 0\}$ is a random process where A and B are independent random variables each of which assumes the values -2 and 1 with probabilities 1/3 and 2/3 respectively. Show that the $X(t)$ is wide stationary process not strict-sense stationary. [CO4, 5 marks]

5. (a) Using shooting method to solve the BVP for a $10m$ rod with

$$\frac{d^2T}{dx^2} + 0.01(20 - T) = 0,$$

h = 5

Boundary conditions $T(0) = 40$, $T(10) = 200$.
Choose $T'(0) = 10$ and $T'(0) = 20$. [CO2, 5 marks]

(b) Using Power method, find approximations (correct to two decimal places) of the smallest eigenvalue and the corresponding eigenvector of the matrix

$$\begin{pmatrix} 2 & -1 & 2 \\ -1 & 1 & -1 \\ 2 & -1 & 3 \end{pmatrix}.$$

Take $\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}^T$ as initial approximation. [CO2, 5 Marks]

BT22ECE039

CENTER FOR VLSI AND NANOTECHNOLOGY

Introduction to VLSI Design

Time: 2:30Hrs | April 2024 | Max.Marks: 50

INSTRUCTIONS TO THE CANDIDATES

1. Assume suitable data whenever necessary and write your assumptions clearly.

Q.1 (a) What will happen to the yield of a process as compared to the initial case, if by reducing the area of a device by half the number of defects also increases by twice the original number, keeping all the other parameters constant. **(3)**

(b) Calculate the approximate time required to grow oxide layer of 100nm thickness through thermal oxidation process using Deal-Grove model. Using the same process and conditions, the time taken to grow 45 nm of oxide layer was 452.5 min having time taken for the linear growth in the process is around 2.5 min. **(4)**

c) List down the major steps, in order, involved in a fabrication of a n-MOSFET? **(6)**

Q.2 (a) Global foundry offers following technology nodes for fabrication: 28nm, 45nm, 12nm, 130nm and 55 nm. Rank the nodes in the descending order of their a) cost b) speed and c) area consumed. **(5)**

(b) You talk to your parent using smartphones. Draw a block diagram showing how the information is being conveyed and listened to depicting the type of signals and their typical frequencies. **(5)**

Q.3 A CMOS compound OR-AND-INVERT (OAI21) gate computing $F = [(A + B) \cdot C]'$ has to be implemented in CMOS layout. Sketch a transistor-level schematic for the gate. Assume input and its complement is available for the design. **(4)**

Q.4. Design and implement pump controller circuit for pumping water (signal OP1) from sump in overhead tank.

1. Pump should not run if pump is empty (IP 1)
2. Pump should switch on if tank is empty (IP 2)
3. Pump should switch off if tank is full (IP 3) **(8)**

Q.5 Design an analogue inverting amplifier for amplifying input in the range of 0-100 mV. The gain of the amplifier should be 20. V_{DD} = 5 V. Output should be centered around 2.5 V. Use the table provided for the transistor characteristics. **(15)**

PTO

BTZZECE039

Department of Electronics and Communication Engineering

Mid Semester Examination, Jan-May 2023-2024

ECL304 - Digital Signal Processing, Slot C

Date: May 01, 2024 (Wednesday) **Time:** 03 Hrs **Max. Marks:** 50

Note: Answer all questions and assume missing data, if any.

1. a) Use the impulse invariance method to design a low-pass digital Butterworth filter to meet the following specification

$$\begin{aligned} \sqrt{(0.5)} \leq |H(e^{j\omega})| &\leq 1 \qquad |\omega| \leq 0.5\pi \\ |H(e^{j\omega})| &\leq 0.2 \qquad 0.75\pi \leq |\omega| \leq \pi \end{aligned}$$

In the absence of aliasing, the impulse invariance method is a linear mapping from $H(j\Omega)$ to $H(e^{j\omega})$ for $|\omega| \leq \pi$, which is given by

$$H(e^{j\omega}) = H(j\Omega)|\,\omega = \Omega T$$

Therefore, to simplify the design, we will assume that there is no aliasing and then, after the design is completed. Also, very and check to see whether the filter satisfies the given specification or not. Because the parameter T does not enter into design using the impulse invariance, for convenience we will set $T = 1$. **[03+04+02=09 Marks, CO4]**

b) Repeat the same filter specifications given in problem 1(a) to design a low-pass digital Butterworth filter using bilinear transformation and show how the bilinear transformation will affect the digital filter in terms of system poles and zeros. Sketch the magnitude spectrum of the designed filter and comment on whether the filter satisfies the given specifications or not, verify it. **[03+02+02 =07 Marks, CO4, CO5]**

2. Consider the following IIR filter

$$H[z] = \frac{1 + 0.5z^{-1} - 0.7z^{-2} + 0.3z^{-3}}{1 + 0.2z^{-1} - 0.81z^{-2} + 0.17z^{-3}}$$

Draw, with clearly indicating the coefficients, the following structure for the IIR filter mentioned above

i) Direct Form I

ii) Direct Form II

iii) Lattice-Ladder **[01+01+04 =06 Marks, CO3, CO4]**

3. Use the bilinear transformation to design a low-pass digital Chebyshev filter to meet the following specifications, **[04+01+02 =07 Marks, CO4, CO5]**

Pass band gain required = -2.5 dB

Frequency up to which pass band gain must remain more or less steady = 100 Hz

Amount of attenuation required = -50 dB

Frequency from which attenuation must start =500 Hz

Sampling frequency = 2000 Hz

For convenience, we will set $T = 1$. Also, Sketch the magnitude spectrum of the designed filter and comment on whether the filter satisfies the given specifications or not, verify it.

4. A researcher would like to filter a signal $x(nT)$ with an appropriate filter according to the following specifications. **[03+02+03=08 Marks, CO4]**

$$\begin{aligned} |H(e^{j\omega})| &\leq 0.0050; & |\omega| &\leq 0.12\pi \\ 0.995 \leq |H(e^{j\omega})| &\leq 1.0050; & 0.25\pi \leq |\omega| &\leq 0.6\pi \\ |H(e^{j\omega})| &\leq 0.0025; & 0.8\pi \leq |\omega| \end{aligned}$$

a) Assist the researcher with the complete design of such filter that is to be implemented as an FIR linear phase filter and symmetric unit sample response.
Also, verify that the designed FIR filter shows the linear phase characteristic.

b) Can you help the researcher by designing the same filter with an anti-symmetric unit sample response? if 'yes', realize the filter and if 'no', justify your answer.

5. Perform Circular convolution between $x[n] = [1, -1, 1, -1, 1, -1, 1, -1]$ and $y[n] = [1, 1, 1, 1, 0, 0, 0, 0]$. You HAVE TO DO IT IN FREQUENCY DOMAIN i.e. USING DFT AND IDFT. DO NOT DO IT IN TIME DOMAIN. For performing DFT and IDFT, you can implement RADIX 2 DIT Algorithm. **[07 Marks, CO2]**

6. Assume you have sampled $f(t) = sin^2[2\pi 60t] + cos^2[2\pi 80t] + cos^2[2\pi 100t]$ using a sampling frequency $F_s = 150Hz$ to generate $f[n]$. a) Draw the magnitude spectra of the sampled signal. b) If you want to reconstruct the continious time domain signal using ideal reconstruction filter, what would the reconstructed signal. **[06 Marks, CO1]**

**********End of Question Paper**********

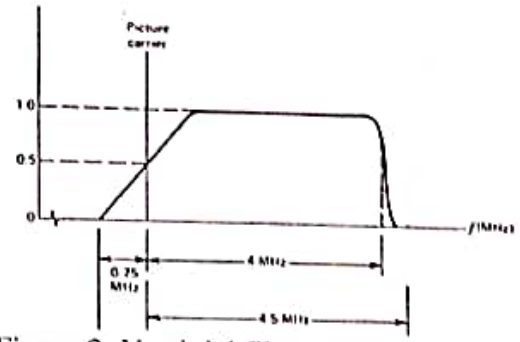
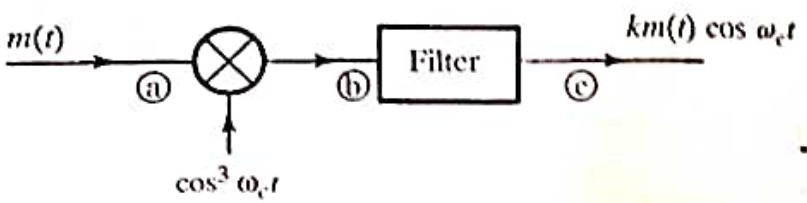
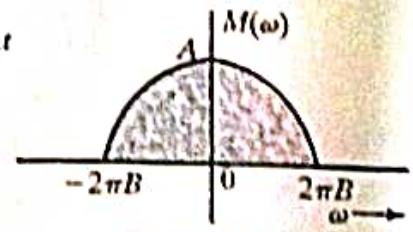
VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

ECE DEPARTMENT

Subject: (ECL301 – Analog Communication)

End semester exam (April-2024) *MARKS: 50*

Instruction: (1) Attempt all questions (2) Make suitable assumption wherever necessary and clearly mention same

5	Estimate the bandwidth of $\emptyset_{FM}(t)$ and $\emptyset_{PM}(t)$ for the m(t) given below $m(t) = 2\cos(100t) + 18\cos(2000\pi t)$ Consider $\omega_c = 10^6$, $k_f = 1000\pi$ and $k_p = 1$.	*CO1* *3 M*
6	For a given message signal $m(t) = \sin(2000\pi t)$, $k_f = 200{,}000\pi$ and $k_p = 10$. What happens to the bandwidth of $\emptyset_{FM}(t)$ and $\emptyset_{PM}(t)$ if (a) the amplitude of m(t) is doubled **(3M)** (b) the frequency of m(t) is doubled **(3M)** (c) Comment on the sensitivity of FM and PM bandwidths to the amplitude and spectrum of m(t). **(2M)**	*CO4* *8 M*
7	A vestigial filter $H_i(w)$ is shown in Figure 2. The picture carrier is at 100 MHz. Find the corresponding transfer function of the equilizer filter $H_o(w)$.  Figure 2: Vestigial filter response $H_i(w)$	*CO3* *4 M*
8	You are asked to design a DSB-SC modulator to generate a modulated signal km(t)cos($\omega_c t$), where m(t) is a message signal band limited to B Hz as shown in Figure 3(b). Figure 3(a) shows DSB-SC modulator available in stock room. The carrier generator available generates not cos($\omega_c t$) but $cos^3(\omega_c t)$. Explain whether you would be able to generate the desired signal using only this equipment. You may use any kind of filter you like. (a) What kind of filter is required in Figure 3(a)? **(1M)** (b) Determine the signal spectra at points b and c, and indicate the frequency bands occupied by these spectra. **(2M)** (c) What is the minimum usable value of ω_c? **(1M)** (d) Would this scheme work if the ccarrier generator output were $cos^2(\omega_c t)$? Explain.**(1M)**  Figure 3(a)  Figure 3(b)	*CO2* *5 M*

BT22ECE039

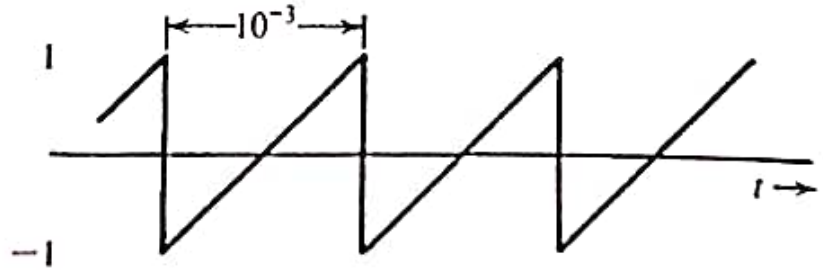
VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

ECE DEPARTMENT

Subject: (ECL301 Analog Communication)

End semester exam (April-2024) *MARKS: 50*

Instruction: (1) Attempt all questions (2) Make suitable assumption wherever necessary and clearly mention same

		CO's & Marks
1	Choose the proper alternatives **(1 Mark each)** 1. An FM signal with a deviation δ is passed through a mixer, and has its frequency reduced sevenfold. The deviation in the output of the mixer is a. a. 7δ b. 2δ c. $\delta/7$ d. δ 2. The condition for NBFM is a. a. mod $k_f a(t) \ll 1$ b. mod $k_f a(t) \gg 1$ c. mod $k_f a(t) = 1$ d. *None of the above* 3. Varactor diode can be used as a. a) amplitude modulator b) frequency modulator b. c) amplitude demodulator d) frequency demodulator 4. A superheterodyne receiver with an IF of 450 kHz is tuned to a signal at 1200 kHz. The image frequency is a. a) 750 kHz. b. 500 kHz c. 1650kHz d. 2100kHz 5. A receiver has poor IF selectivity. It will therefore also have poor a. a. blocking b. double spotting b. c. diversity reception d. sensitivity	CO1 5M
2	a) How the demodulation of FM can be done with the help of hard limiter? **(3M)** b) How a FM signal can be generated by direct method? **(3M)** c) Compare the performance of TDM and FDM. **(2M)** d) State and prove sampling theorem. **(2M)**	CO2 CO3 10 M
3	a) How PAM, PWM and PPM signal can be generated? **(4M)** b) Compare the performance of DSB-SC and baseband systems in presence of noise. **(6M)**	CO5 10 M
4	Periodic baseband signal m(t) is is shown in Figure 1. Sketch $\theta_{FM}(t)$ and $\theta_{PM}(t)$ for this signal if $\omega_c = 2\pi \times 10^6$, $k_f = 1000\pi$ and $k_p = \pi/2$. **(3M)**  Figure 1: Periodic saw tooth wave Explain, what happens if $k_p = \pi$. **(2M)**	CO4 5 M

Visvesvaraya National Institute of Technology, Nagpur
Department of Mathematics
Linear Algebra and Partial differential Equations (MAL-210)(ECE)

End Semeseter Examination - Summer 2024

Time: 3 hours **Max Marks: 50**

Note: Use of calculator is not allowed.

Section A

Attempt all five questions from Section A. [2 × 5 = 10]

1. (a) Find a linear mapping $T : \mathbf{R}^3 \to \mathbf{R}^3$ whose image is spanned by $(1, 2, 3)$ and $(4, 5, 6)$. [CO1, 2]

   (b) Find an orthogonal matrix P whose first row is $(1/3, 2/3, 2/3)$. [CO1, 2]

   (c) Find the projection of a vector $v = (1, 3, 5, 7)$ onto W, where W is the subspace of $\mathbf{R}^4$ spanned by $u_1 = (1, 1, 1, 1)$ and $u_2 = (1, 2, 3, 2)$. [CO2, 2]

   (d) If T is a self-adjoint operator on a vector space V and λ is an eigen value of T, show that λ is real. [CO2, 2]

   (e) Classify the differential equation: $(1 - x^2)\frac{\partial^2 z}{\partial x^2} - 2xy\frac{\partial^2 z}{\partial x\, \partial y} + (1 - y^2)\frac{\partial^2 z}{\partial y^2} - 2z = 0$. [CO4, 2]

Section B

Attempt all four questions from Section B. [10 × 4 = 40]

2. (a) Define self-adjoint, unitary(orthogonal) and normal operators. Show that self-adjoint and unitary(orthogonal) operators are normal. Also prove that if T is normal on an inner product space V, then $\|T(v)\| = \|T^*(v)\|$ for every $v \in V$. [CO2, 4]

   (b) Find the least squares straight line fit to the four points (0,1), (1,3), (2,4) and (3,4). [CO2, 3]

   (c) Find the QR decomposition of the matrix

$$A = \begin{pmatrix} 1 & 1 & 2 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}.$$

[CO3, 3]

3. (a) Find singular value decomposition (SVD) of the matrix

$$A = \begin{pmatrix} 0 & 1 & 1 \\ \sqrt{2} & 2 & 0 \\ 0 & 1 & 1 \end{pmatrix}.$$

[CO3, 6]

(b) Find the complex form of Fourier series for

$$f(x) = \begin{cases} kx, & \text{if } 0 < x < l, \\ 0, & \text{if } l < x < 2l. \end{cases}$$

[CO3, 4]

4. (a) Obtain the Fourier expansion of $f(x) = \sqrt{(1 - \cos(x))}$ in $(0, 2\pi)$. Hence, show that $\frac{1}{1.3} + \frac{1}{3.5} + \frac{1}{5.7} + \ldots\ldots\infty = \frac{1}{2}$. [CO3, 5]

(b) The temperature distribution in a bar of length 100 cm which is perfectly insulated at ends $x = 0$ and $x = 100$ is governed by partial differential equation

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}.$$

Assuming the initial temperature distribution as $u(x, 0) = x$, find the temperature distribution at any instant of time.

[CO4, 5]

5. (a) Obtain a half-range sine series for

$$f(x) = \begin{cases} \frac{1}{4} - x, & \text{when } 0 < x < \frac{1}{2}, \\ x - \frac{3}{4}, & \text{when } \frac{1}{2} < x < 1. \end{cases}$$

[CO3, 4]

(b) The bounding diameter of a semi-circular plate of radius a cm is kept at $0°C$ and the temperature along the semi-circular boundary is given by

$$u(x, \theta) = \begin{cases} 10\theta, & \text{when } 0 < \theta < \frac{\pi}{2}, \\ 10(\pi - \theta), & \text{when } \frac{\pi}{2} < \theta < \pi. \end{cases}$$

Find the steady-state temperature function $u(r, \theta)$. [CO4, 6]

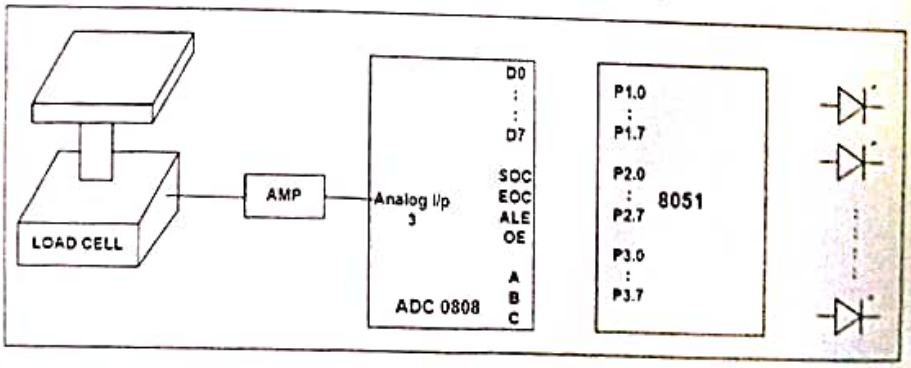
Visvesvaraya National Institute of Technology, Nagpur

Department of Electronics and Communication Engineering

End Semester Examination (2023 – 2024)

Sub: (ECL315) MICROPROCESSORS AND MICROCONTROLLERS | **Time:** 3 Hrs | **Max. Marks:** 55

1. Use Hexadecimal numbers (default) for calculations
2. Numbers (Bold and Italics) on right hand side indicates marks. [CO] indicates COs.
3. ***Assume suitable data if necessary and specify it in your code at the beginning.***

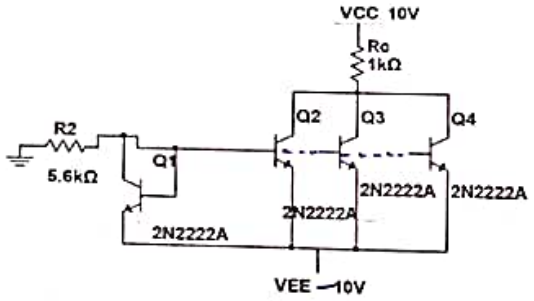
Q.1(a)	Identify the addressing modes and compute physical address for specified operand in each of the following instructions with respect to microprocessor 8086. Register contents and variables are as follows. CS = 0B00H, DS = 0C00H, SI = 1000H, DI = 0200H, BX = 0300H. i. MOV CX, 0300H [BX] ii. MOV BL, [SI][BX] iii. ADD AX, [5000H] iv. SUB AX, [SI]	*[CO1, CO2] 5M*
Q.1 (b)	Write an assembly language program for microprocessor 8086 to find largest number from series of 100 numbers (8-bit) stored at memory location 1000H:2000H onwards. Store the largest number at 2000H:4000H.	*[CO2] 5M*
Q.2 (a)	Draw the structure for internal RAM of microcontroller 8051. Write an assembly language program for microcontroller 8051 to move 10 bytes stored in external RAM at address 2000H to internal RAM at 60H.	*[CO2] 5M*
Q.2 (b)	Write an assembly language program for microcontroller 8051 to solve following equation: $Y = \bar{A}.B + AB + A\bar{B}$ using following: i) Accumulator bits for A and B are ACC.0 and ACC.1 respectively. Store Y at MSB of accumulator ii) Internal RAM locations for A and B are 20.0 and 20.1 respectively. Store Y at 20.3	*[CO1, CO2] 5M*
Q. 3	Write an assembly language program for microcontroller 8051 for the smart scale system as given below. The data (weight) from ADC is read by microcontroller 8051 and displayed as digital data on eight LED's connected to Port 2 of microcontroller 8051. Make suitable connections for remaining control signals of ADC. Complete the interfacing diagram for the given system and write assembly language program for the given system. 	*[CO3, CO4] (10M)*

Q. 4	Write assembly language program for microcontroller 8051 to generate square wave on Port 0. System Clock used is 11.0592MHz. Use Timer0 in Mode-1. Draw format for TCON and TMOD and state the function of TR1 and TR0 bits.	[CO2, CO3] (10M)
Q. 5	For a musical concert, a lighting system is to be arranged. The focus lights are attached to a 200-teeth, 4 phase stepper motors so that the positions of focus lamps will be adjusted according to the rotation of motor. The motor rotates at a speed of 10 rotations per minute continuously. Assume f=11.0592MHz. Write an assembly language program for microcontroller 8051. Calculate the required delay and write delay program for the same.	[CO1] (10M)
Q.6	What are the key features and characteristics of an RTOS? How does RTOS differ from a general-purpose operating system?	[CO5] (5M)

Department of Electronics & Communication Engineering, VNIT, Nagpur.
End Sem Exam May 2024
Fourth Sem B.Tech (Electronics & Communication)
Analog circuit design (ECL308) BT22ECE039
Slot- G

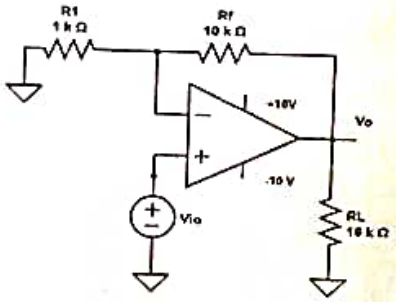
Time: 3 Hrs Marks: 55

Q.1a) For the ckt shown, determine current through Rc and collector current in each transistor. (CO1,05)



b) An inverting amplifier is designed for a gain of 40 dB using an Op-Amp having an open loop gain of 250000 and a unity-gain frequency of 750 kHz. Find the bandwidth of the designed amplifier. (CO1, 02)

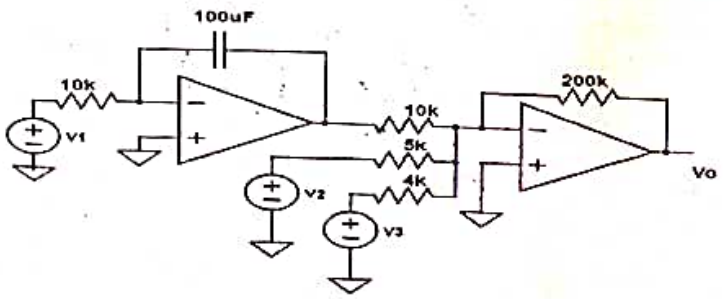
c) In the circuit shown, V_{io} =10mV. The maximum possible output offset voltage V_o caused by input offset voltage V_{io} with respect to ground is ___. (CO1 ,02)



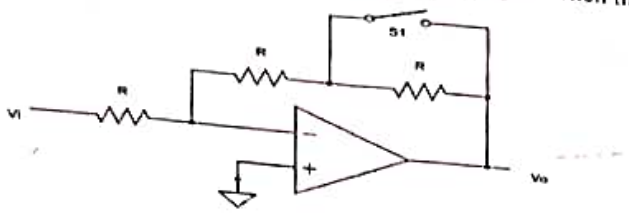
d) An amplifier has a differential voltage gain of 4200 and a CMRR of 25,000. A single ended i/p signal of 500μV rms is applied. Also 1V rms common mode interference signal appears on both inputs :

a. Find Acm
b. Express CMRR in dB.
c. Determine the rms o/p signal .
d. Determine the rms interference (common mode) voltage appearing on the output. (CO4, 05)

Q.2a) With the ideal operational amplifier find the expression for output voltage Vo. (CO4 ,02)



b) Let the magnitude of the gain in the inverting Op-Amp amplifier circuit below shown be x with switch S1 open. Find the magnitude of gain when the switch is closed. (CO4 ,02)



c) For an integrator if R1= 10kΩ, C= 10nF and i/p is a square wave with frequency of 10 kHz. Draw Vo. Also generate the equation using single op-amp,
Vo = - ∫ (V1+2V2+10V3) dt .Use C=1μF

Q.3a) Design a square wave generator which is adjustable from 5 kHz to 20 kHz. (CO4, 03)

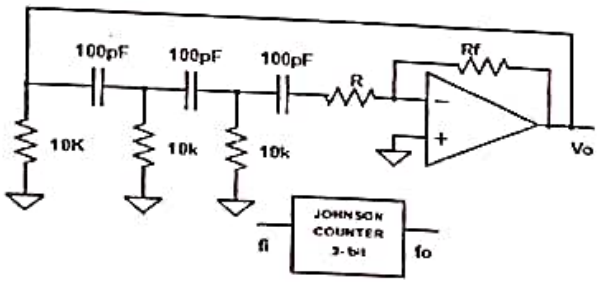
b) Design a low pass filter to meet the following specifications. (CO3, 03)
1) relative attenuation < 3 dB for f < 1 KHz (CO2, 07)
2) relative attenuation > 35 dB for f > 4 kHz

No. of Poles	C1(F)	C2(F)	C3(F)
2	1.414	0.7071	
3	3.546	1.392	0.202

In the final circuit, choose value of C1 as 0.047 μF.

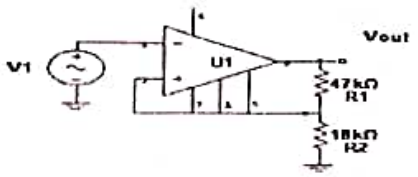
c) A particular application requires that all frequencies below 400 Hz should be attenuated. The attenuation should be at least −22 dB at 100 Hz. Design a filter to meet this requirement. (CO3, CO5, 03)

d) In the given circuit shown below, the frequency of oscillation is given to the input of the 3-bit Johnson counter. Find the output frequency of the Johnson counter. (CO3 ,03)



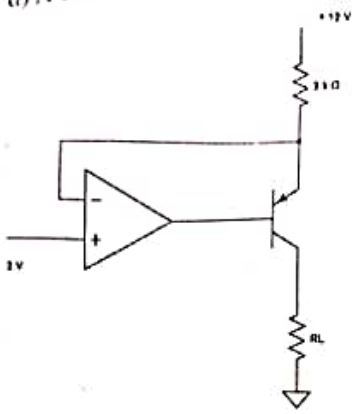
Q.4a) Design a circuit to give Vo= x^2 , where x is the input. Use log and antilog amplifiers. (CO4, 02)

b) Draw a 3 bit R-2R Digital to analog convertor. What will be the analog output if input is 101? Explain. (CO1 ,02)

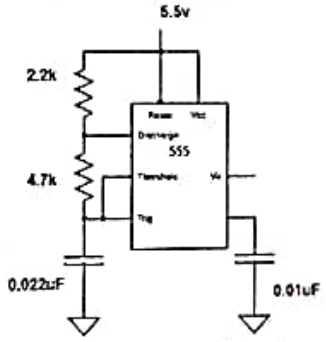


c) Calculate VUTP and VLTP in the given figure. Vout(max)= ± 10 V. Also plot hysteresis for the same (CO3, 02)

d) A circuit is shown below. What is the largest value of R_L that can be used? (CO2 ,02)



Q.5a) Consider the 555 timer configured in the astable mode (oscillator) shown below. Find the frequency of output and duty cycle. (CO5 ,03)



b) A PLL is locked onto an incoming signal with a peak amplitude of 250 mV and a frequency of 10 MHz at a phase angle of 30^0. The 400 mV peak VCO signal is at a phase angle of 15^0.

i) What is VCO frequency?

ii) What is the value of control voltage being fed back to the VCO at this point? (CO5, 04)

c) Design a circuit using IC 723 to give regulated voltage of 6 V with 1 A current. (CO5 ,03)

Solution Awaited

Department of Electronics and Communication, VNIT, Nagpur
End Semester Exam Summer-2024 (Even Sem)
Sixth Sem ECE
ECL 305:EMF

Time: 3 Hrs Max. Marks:50

Due credit will be given for units. Assume suitable data wherever necessary.

Q.1. Answer any 5 out of the following:

i. Consider a magnetic flux density $B = 2a_x + 6a_y\ Wb/m^2$ with a current element 0.3 a_z (mA-m) placed in it. What will be the force per meter on this current element?

ii. A magnetic flux through a coil is perpendicular to its plane. It is directed into paper. It is varying as per relationship $\phi = 10t^2 + 5t + 6$ mWb. Find the induced emf in this loop at time t=15s.

iii. A parallel plate capacitor has a plate area of 15 cm^2. Plate separation is 6 mm. A voltage of 25 sin 10^2t Volt is applied to its plates. Find the displacement current. (Assume $\varepsilon = 3\varepsilon_0$)

iv. Find the angle by which direction of E changes, as it crosses the boundary between two dielectrics if ε_{r1}=9 and ε_{r2}=8.

v. What is skin depth at 6.4 MHz in Al, which is characterized by σ=38.2 (MS/m) and μ_r=1.

vi. Find the reflection coefficient of an electric field wave that is travelling in air and is incident normally on a boundary between air and a dielectric medium. Assume μ_r=8 and ε_r=2. **[10] [CO-1 to 5]**

Q.2. a. The loop shown in Figure 1 is inside a uniform magnetic field B = 50 a_x mWb/m^2. If side *DC* of the loop cuts the flux lines at the frequency of 50 Hz and the loop lies in the yz-plane at time t = 0, find
(i) The induced emf at t = 1 ms
(ii) The induced current at t = 3 ms **[5] [CO-2]**

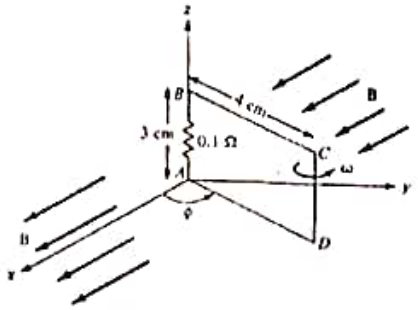


Figure 1

Q.2. b. In a medium characterized by σ = 0, $\mu=\mu_0$, $\varepsilon=\varepsilon_0$ and E = 20 sin (10^8t - βz) a_y V/m ,Calculate β and H. **[5] [CO-4]**

Q.3. a. A uniform plane wave propagating in a medium having $E = 8e^{-\alpha z}\sin(18\times10^7 t - \beta z)a_y$ V/m. The medium is characterized by μ_r=20, ε_r=4 and σ=2 (Ω^{-1}/m). Find (i) type of medium (ii)α (iii)β (iv)intrinsic impedance (v) H. **[5] [CO-4]**

Q.3. b. In a transmission line filled with a lossless dielectric ($\mu = \mu_0$, $\varepsilon = 4.5\ \varepsilon_0$), E=40/$\rho$ sin (ωt-2z) a_ρ V/m. Find (i) ω and H (ii) poynting vector (iii) total time-average power crossing the surface z=1 m, 2mm <ρ<3 mm, 0<ϕ<2π. **[5] [CO-5]**

Q.4. a. For a current distribution in free space, $A = (2x^2y + yz)a_x + (xy^2 - xz^3)a_y - (6xyz - 2x^2y^2)\ a_z$ Wb/m.
(i) Calculate B (ii) Find the magnetic flux through a loop described by x = 1, 0 < y, z < 2 (iii) Show that $\nabla \cdot A = 0$ and $\nabla \cdot B = 0$. **[5][CO-1,3]**

Q.4. b. In a certain region, the electric field is given by $D = 2\rho(z + 1)\cos\phi\ a_\rho - \rho(z + 1)\sin\phi\ a_\phi + \rho^2\cos\phi\ a_z\ \mu C/m^2$ (i) Find the charge density (ii) Calculate the total charge enclosed by the volume 0<ρ<2, 0<ϕ<π/2, 0<z<4. (iii) Confirm Gauss's law by finding the net flux through the surface of the volume in (ii). **[5] [CO-2]**

Q.5. a. A ring placed along $y^2 + z^2 = 4$, x = 0 carries a uniform charge of 5 μC/m. (i) Find D at P(3,0, 0). (ii) If two identical point charges Q are placed at (0, -3, 0) and (0, 3, 0) in addition to the ring, find the value of Q such that D = 0 at P. **[5] [CO-2]**

Q.5.b. Given the vector field $G = (16xy - z)\ a_x + 8x^2\ a_y - x\ a_z$
(i) Is G irrotational (or conservative)? (ii) Find the net flux of G over the cube 0 < x, y, z < 1. (iii) Determine the circulation of G around the edge of the square z = 0, 0 < x, y < 1. Assume anticlockwise direction. **[5] [CO-1]**