Q. No. ECC 01/ 476

B.TECH / EVEN
REG / (22 – 23)

Even Semester End-term Examination, 2022-23

BASIC ELECTRONICS

ECC 01

Full Marks : 60 *Time* : 180 Minutes

The figures in the margin indicate full marks.

Answer *all* the questions.

Question No.	Body of the Question	Marks	Mapped CO

1. (A) What do you mean by ripple factor (Y) of rectifier? Show that the ripple factor of a rectifier $Y = (V^2_{rms} - V^2_{dc})^{1/2} / V_{dc}$; where V_{rms} is the the rms value of the total load voltage and V_{dc} is the average or dc load voltage. 5 CO1

   (B) Differentiate between Zener breakdown and Avalanche multiplication. 5 CO2

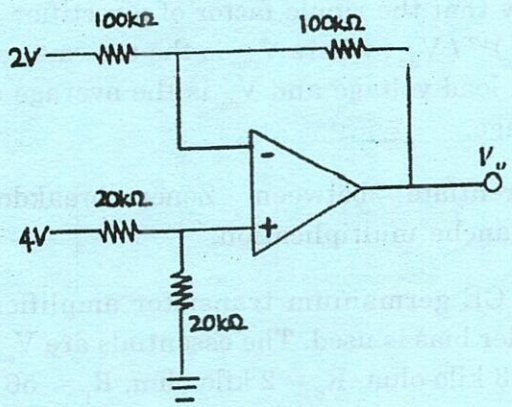
   (C) In a CE germanium transistor amplifier, voltage divider bias is used. The essentials are V_{cc}=16 volts, R_c = 3 kilo ohm, R_E = 2 kilo ohm, R_1 = 56 kilo ohm, R_2 = 20 kilo ohm, $\beta/(\beta+1) = 0.985$. Derive the expression for Ic and V_{CE} and determine the operating point. 5 CO2

2. (A) With the help of a circuit diagram, demonstrate frequency response of a CE amplifier having a sinusoidal signal as input. 5 CO3

(B) Explain the drain characteristics for n-channel JFET with proper circuit diagram. 5 CO1

(C) The change in gain of an amplifier without feedback is ±10%. Find the percent change in gain when 20dB negative feedback is introduced. If the gain of the internal amplifier is 1000, find the feedback ratio and the overall gain of the feedback amplifier. 5 CO2

3. (A) Report the output voltage of the given circuit 5 CO4



(B) Use 2 ideal op-amps and resistors to implement the summing function $V_o = 2V_1 + 3V_2 - 2V_3 - 6V_4$ 5 CO3

(C) Explain with a circuit diagram the action of a Wien-bridge oscillator. Find an expression for the

(*Continued*)

frequency of oscillation. Show that for a Wien-bridge oscillator the minimum closed loop gain of the amplifier should be 3. 5 CO4

4. (A) Realize the following logic gate operations using NOR gates only. 5 CO5 + CO3

- AND
- OR
- NOT
- XOR

(B) Prove the following Boolean identities 5 CO5

i) $x + yz=(x+y)(x+z)$

ii) $x(\bar{x} +y) = xy$

(C) Simplify the expression $Y=\bar{A}BC+A\bar{B}C+AB\bar{C}+ABC$ and implement the function Y making use of NAND gates only. 5 CO5+CO3

COURSE OUTCOMES

(a) CO1: **Describe** the operation of various semiconductor devices. **(Level 2 of Bloom's Taxonomy)**

(b) CO2: **Analyze** basic electronic circuits, construction and operation. **(Level 4 of Bloom's Taxonomy)**

(c) CO3: **Apply** the designs using various circuit elements for different applications **(Level 3 of Bloom's Taxonomy)**

(d) CO4: **Identify** the role of Op-amps for various signal processing applications. **(Level 2 of Bloom's Taxonomy)**

(e) CO5: **Understand** the basic digital gates and the block diagram of wireless system. **(Level 2 of Bloom's Taxonomy)**

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Q. No. ECC - 401

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2022-23

ANALOG COMMUNICATION

ECC - 401

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* questions.

1. (a) When a super heterodyne receiver is tuned to 555 KHz, its local oscillator provides the mixer with an input at 1010 KHz, what is the image frequency ?

   (b) Three message signals each bandlimited to 5 KHz are multiplexed using FDM. Guard band is 1 KHz. Find multiplexed signal bandwidth, if the modulation schemes used are AM, DSB and SSB, respectively.

   (c) State and prove the sampling theorem. 3+5+4 [CO3]

2. (a) Explain the operation of a noise limiter in FM receivers ?

   (b) Illustrate the FM detection by a PLL with the help of its schematic.

   (c) What is frequency drift ? How is it avoided ?

   (d) A 12 MHz carrier gets modulated by a sine signal with a frequency of 500 Hz bearing the frequency deviation of about 50 KHz. Find the bandwidth. 2+4+3+3 [CO4]

P.T.O.

3. (a) Define Noise figure.

   (b) In a binary communication channel, 9000 bits are transmitted. The error probability in the channel is 0.001. What is the probability that the total number of bits in error is more than 2 ?

   (c) A white noise with two-sided PSD of 10^{-7}W/Hz is applied at the input of a RC low pass filter (assume suitable values for R and C). Find the total average power at the output of the filter. 2+4+6 [CO5]

4. (a) Give the general representation of noise in communication system and calculate the power spectral density of it for base band communication system.

   (b) Describe a PWM based communication system with suitable schematic. 7+5 [CO6]

5. Write short notes on any *two* : 6+6 [CO1 ; CO2]

   (i) DSB-AM

   (ii) EM wave propagation

   (iii) Electronic Communication System.

Course Outcomes :

CO1 : Define and state the elements of communication systems and issues related to transmission of signals through communication channels, radio wave propagation.

CO2 : Explain time and frequency domain equations for all forms of amplitude modulation schemes and corresponding circuits, signals and spectra.

CO3 : Use various analog pulse communication systems and solve problems related to FDM and super heterodyne receiver.

CO4 : Formulate time and frequency domain equations for angle modulation systems and justify related circuits, signals and spectra.

CO5 : Differentiate between various types of noise, and compare noise resistance, noise figure and noise temperature and discuss probability theory, random variables and random processes with related significance in communication systems.

CO6 : Assemble complete analog communication system and formulate the expression of figure of merit for different schemes of modulation.

Q. No. ECC - 402 111 ND/B.Tech./Even

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2022-23

DIGITAL CIRCUITS AND SYSTEMS

ECC - 402

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* the questions.

1. (a) Determine the output waveforms in relation to the clock for Q_A, Q_B and Q_C in the circuit of Figure 1 and show the binary sequence represented by these waveforms (timing diagram).

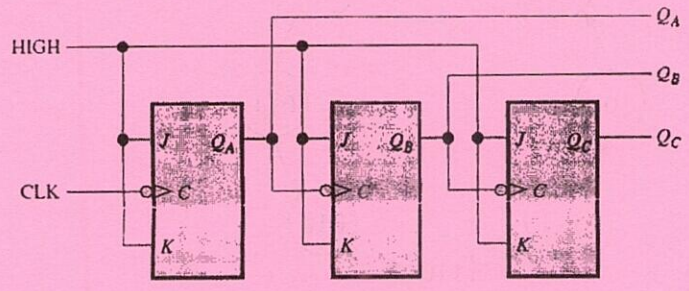

Figure-1

(b) Explain the design of a 4 bit basic register using D-Flip Flop for parallel data storage (Parallel data in and parallel data out) with timing diagram. 5+5 [CO5]

P.T.O.

2. (a) Design a 4-bit look ahead carry adder circuit and explain its advantages over ripple carry adder circuits.

   (b) Design an asynchronously clocked decade counter (MOD-10) using D-Flip Flop and draw its timing diagram. 5+5 [CO1, CO3]

3. (a) Design and implementation of the Boolean function as given below using a multiplexer (8×1 MUX)

   $$F(A,B,C,D) = \Sigma m(1,3,4,11,12,13,14,15)$$

   (b) Design a 3-bit Gray code synchronous counter using J-K Flip Flops which follow the given state diagram as shown in Figure 2. 4+6 [CO2, CO3, CO6]

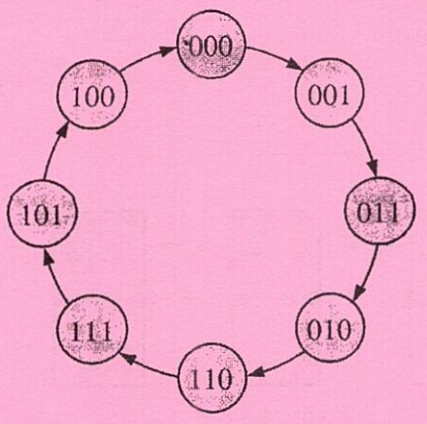

Figure 2

4. (a) Design a BCD-to-excess-3 code converter using logic gates.

(b) Determine the binary numbers for the following hexadecimal numbers : (i) 10A4 (ii) CF8E

Convert the following binary numbers to hexadecimal : (iii) 10110011 (iv) 110011101000

Convert each decimal number to binary : (v) 21 (vi) 0.375

Convert the binary number to decimal : (vii) 1101101 (viii) 0.1011

(c) Use NAND gates, NOR gates, or combinations of both to implement the following logic expressions as stated :

(i) $X = \overline{A}B + CD + \left(\overline{A+B}\right)\left(ACD + \overline{BE}\right)$

(ii) $X = AB\overline{C}\overline{D} + D\overline{E}F + \overline{AF})$

(iii) $X = \overline{A}\left[B + \overline{C}\left(D+E\right)\right]$ 4+3+3 [CO6, CO1]

5. (a) Simplify the following Boolean expressions to a minimum number of literals :

(i) $ABC + \overline{A}B + AB\overline{C}$

(ii) $\overline{x}yz + xz$

(iii) $\overline{(x+y)}(\overline{x}+\overline{y})$

(iv) $xy + x\left(wz + w\overline{z}\right)$

(b) Simplify the following Boolean function into sum-of-products form and (b) product-of-sums form :

$F(A, B, C, D) = \Sigma m(0, 1, 2, 5, 8, 9, 10)$

P.T.O.

(c) Implement a 3 bit Even-Parity-Generator with truth table and logic diagram. 2+3+5 [CO1, CO2, CO3]

6. Write a short note on any *two*: 5×2 [CO4, CO5, CO6]

(a) Design and explain an Astable Multivibrator using 555 Timer IC.

(b) Briefly explain the types of Finite State Machine (FSM) models used in sequential circuits with proper examples.

(c) Explain the type of logic families used in integrated circuit technology and compare the performance of TTL and CMOS technology.

(d) Explain different types of D/A and A/D Converters.

Course Outcomes :

CO1 : Understand rules of Boolean Algebra and use it for logic synthesis.

CO2 : Design sequential logic circuits using switches, transistors and integrated circuit building blocks.

CO3 : Understand binary number system and design corresponding arithmetic circuits.

CO4 : Explain and implement A/D and D/A converters, multivibrator circuits.

CO5 : Learn sequential circuit building blocks and implement Finite State Machines.

CO6 : Understand principles of codes convergence.

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2022-23

ELECTROMAGNETIC THEORY AND TRANSMISSION LINES

ECC - 403

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions.

1. State and prove Poynting's theorem. Define the Poynting's vector and explain its physical significance. 12

2. What is surface impedance ? Derive its expression. Calculate the real and imaginary parts of surface impedance for copper $\left(\sigma = 5.8 \times 10^7 \text{ mho/m}\right)$ at a frequency of 1 MHz. 12

3. What do you mean by uniform plane waves ? A uniform plane wave has no component of electric and magnetic field in the direction of propagation. Prove it. Consider the medium to be a perfect dielectric. 12

4. (a) Derive the expression for the velocity of propagation of a uniform plane wave propagating in a perfect dielectric. 6

   (b) Show that for a transverse electromagnetic wave propagating in a perfect dielectric, the ratio between the electric field and the magnetic field amplitudes is $\sqrt{\frac{\mu}{\epsilon}}$. 6

P.T.O.

5. Derive the expressions for characteristic impedance and propagation constant of a transmission line in terms of line parameters. The constants for a 25 mile long cable per mile are : R=4.5Ω, L=1.2mH, C=0.06μF, G=5μmho. Find the characteristic impedance and propagation constant at a frequency of 796 Hz. 12

6. (a) Derive the expressions for voltage and current along a transmission line. 8

   (b) Derive the expression for input impedance of a transmission line of length '*l*'. 4

7. Explain the following in brief in connection with a transmission line :

   (a) Frequency distortion, Distortionless condition and its derivation. 5

   (b) Delay or phase distortion, Distortionless condition and its derivation. 5

   (c) A finite transmission line terminated by its characteristic impedance behaves as an infinite line and a smooth line. 2

8. (a) Derive the expressions for voltages and currents on an open circuited and short circuited dissipationless lines. 6

   (b) Find the input impedances of on open circuited and short circuited dissipationless line and also plot them as a function of length for $3\frac{1}{2}$ wavelength long. 6

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ANTENNA AND WAVE PROPAGATION

ECC - 601

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* the questions.

Section - A

1. For an antenna power pattern is given as $\cos\theta(0 \le \theta \le \pi)$. Evaluate the directivity of the antenna. 2 [CO1]

2. State the principle of pattern multiplication. 2 [CO4]

3. An antenna is operating at wave-length of 2 m and has a directivity of 100. Determine its maximum effective aperture. 2 [CO2]

4. A transmitting antenna having an effective height of 100 meters with current of 100 A is operating at the frequency 300 KHz. Find out the radiated electric field strength at a distance of 100 km. 2 [CO5]

5. A center-fed linear dipole antenna with one and a half-wavelength long has a feed current of 10A (rms). Calculate the current on the antenna at 3/4 wavelength away from the feed point. 2 [CO3]

P.T.O.

Section - B

1. (a) A plane wave travelling along the + z direction in the air having following x and y components of the field.

$$E_x = 2\sin(\omega t - \beta z)$$

$$E_y = 4\sin(\omega t - \beta z + \phi)$$

Determine the type of polarization of the wave and sense of rotation if any when (i) $\phi = 90°$, and (ii) $\phi = 0°$.

Also calculate the average power per unit area conveyed by the wave.

(b) An antenna with effective aperture (A_{em}) and directivity (D) is operating at wavelength (λ). Show that

$$A_{em} = \frac{D\lambda^2}{4\pi}.$$

7+3 [CO1, CO3]

2. (a) From the radiated field expressions of the half-wave dipole, obtain its directivity, maximum effective aperture and radiation resistance.

(b) A certain antenna with an efficiency of 95% has maximum radiation intensity of 0.5 W/sr. Calculate its directivity when,

(i) The input power is 0.4 W

(ii) The radiated power is 0.3 W 6+4 [CO1, CO3]

3. (a) Deduce the Friis Transmission formula, $P_r = P_t \frac{A_{er} A_{et}}{r^2\lambda^2}$; where the symbols have their usual meanings.

(b) Obtain the expression for the beamwidth of an end-fire array.

(c) For an end-fire array of isotropic radiators spaced by half wavelength is to have directive gain of 30. Find the array length and the beamwidth between first nulls (BWFN) of the major lobe. 3+3+4 [CO5]

4. (a) Briefly describe about the layer of the ionosphere and their effects on the sky wave propagation.

(b) Discus the significance of skip distance. Derive the relationship between MUF and skip distance.

(c) A police radio transmitter operating at a frequency 1.69 GHz is required to provide a ground wave having strength of 0.5mv/m at a distance of 16km. The transmitter antenna, having an efficiency of 50% produces a radiating field proportional of $\cos\theta$. The ground wave has $\sigma = 5 \times 10^{-5}$mho/cm and $\varepsilon_r = 15$. Calculate the power transmitted. 3+3+4 [CO2]

5. Write short notes on the following :

(a) Parabolic Reflector Antenna

(b) Microstrip Patch Antenna 5+5 [CO4]

Or,

(a) Horn Antenna

(b) Log periodic dipole array 5+5 [CO4]

P.T.O.

Course Outcomes :

CO1 : **Explain** the concepts of antenna radiation patterns and various parameters for characterizing the antenna.

CO2 : **Understand** different modes of radio wave propagation.

CO3 : **Classify** various antennas on the basis of their electrical performances.

CO4 : **Analyze** various antennas and antenna arrays.

CO5 : **Design** antenna and antenna arrays for different applications.

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VLSI DESIGN

ECC - 602

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* the questions.

Graph paper shall be supplied, if required.

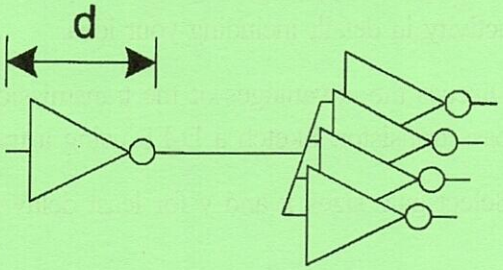
1. (a) Explain the VLSI Design Flow.

   (b) Compare the full custom and semi-custom design flow with examples. 8+2=10 [CO3]

2. (a) What are the advantages of CMOS Inverter? Draw the circuit of CMOS inverter. Explain the working of CMOS inverter.

   (b) What will be the problems arise with continuous scaling down of transistors? 1+2+5+2=10 [CO2, CO1]

3. (a) Estimate the delay of a fanout-of-4 (FO4) inverter.



P.T.O.

(b) Design a 4 : 1 Mux using

(i) fundamental gates,

(ii) universal gates, and

(iii) compound gates.

Do all the topologies experience same delay? Which will have least delay? Explain. 5+5=10 [CO5]

4. (a) VLSI design can be broken into three broad categories : Analog, Digital, and Mixed Signal IC design.

(i) If you want to go for the Digital domain for the Analog domain? Please specify with justifications.

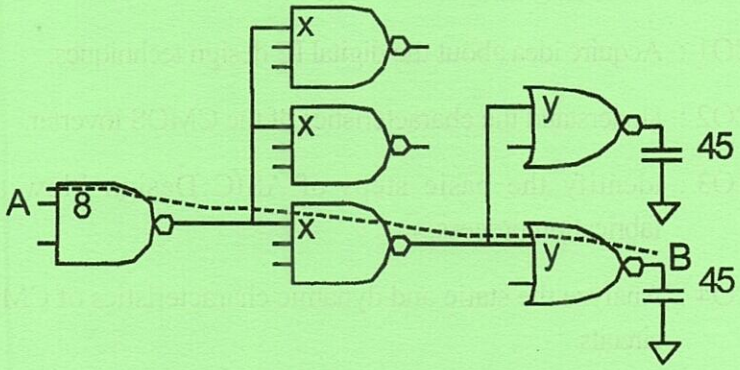
(ii) What skill sets and EDA tools are required for the Digital domain? Please specify with justifications.

(iii) What skill sets and EDA tools are required for the Mixed Signal domain? Please specify with justifications.

(b) Suppose you've got a great idea for the real application. You plan to design a digital IC and fabricate it for the commercial product using TSMC process flow. For that, you have to follow a couple of steps to design a chip for the real application. Please explain each and every activity in detail, including your idea. 3+7=10 [CO6]

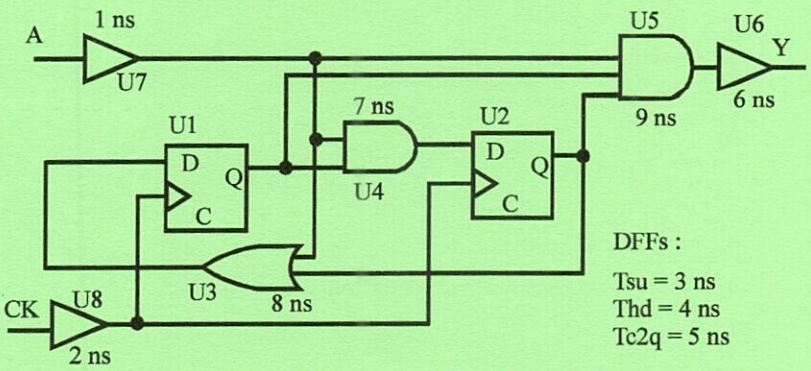
5. (a) Discuss the advantages of the transmission gate over the pass transistor. Sketch a D-FF using a transmission gate.

(b) Select gate sizes x and y for least delay from A to B.



5+5=10 [CO5]

6. In order to work correctly, what should be the Setup and Hold time at Input A in the following Circuit. Also find out the maximum operating frequency for this circuit. (Note : Ignore Wire delay). Where Tsu-Setup time; Thd-Hold Time; Tc2q-Clock-to-Q delay.



10 [CO5]

P.T.O.

Course Outcomes :

CO1 : Acquire idea about the digital IC design techniques.

CO2 : Understand the characteristics of the CMOS inverter.

CO3 : Identify the basic steps of ASIC Design Flow and fabrication process.

CO4 : Analyze the static and dynamic characteristics of CMOS circuits.

CO5 : Design and implementation of combinational and sequential circuits.

CO6 : Evaluate the performance of CMOS circuits.

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DIGITAL SIGNAL PROCESSING

ECC - 603

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* the questions.

Assume missing data, if any, suitably.

1. What is the warping effect? Mention the differences between Linear convolution and circular convolution. Compare FIR and IIR filters. 10 [CO1]

2. Find the circular convolution using DFT/IDFT of the following sequences : $x(n) = \{1,1,-1,2\}$ and $h(n) = \{1,2,3,4\}$. Find an 8-point DFT of a sequence and plot the magnitude and phase spectrum.

$$x(n) = \begin{matrix} 1 & \text{for } 0 \le n \le 2 \\ 0 & \text{otherwise} \end{matrix}$$ 10 [CO2]

3. Find the inverse z-transform of $\frac{z}{6z^2 - 5z + 1}$. A causal system has input $x(n)$ and output $y(n)$. Find the system function, frequency response and impulse response of the system :

P.T.O.

$x(n)=\delta(n)+\frac{1}{6}\delta(n-1)-\frac{1}{6}\delta(n-2)$ and

$y(n)=\delta(n)-\frac{2}{3}\delta(n-1)$. 10 [CO3]

4. Apply Bilinear transformation to $H(s)=\frac{2}{(s+1)(s+2)}$, when $T=1$ sec, and find $H(z)$. An analogue filter has a transfer function $H(s)=\frac{10}{s^2+7s+10}$. Design a digital filter equivalent to this using impulse invariant method for $T=0.2$ sec. 10 [CO4]

5. Given the specifications, $\alpha_p=3dB$, $\alpha_s=16dB$, $f_p=1kHz$, $f_s=2kHz$. Determine the order of the filter using the Chebyshev approximation. Find $H(s)$. 10 [CO5]

6. Find the linear convolution between the sequences using (a) overlap save method and (b) overlap-add method :

   $X(n)=\{1,2,-1,2,3,-2,-3,-1,1,1,2,-1\}$ and $h(n)=\{1,2\}$. Use $N=4$. 10 [CO3]

Course Outcomes :

- CO1 : Represent signals in the time and frequency domain.
- CO2 : Implement DFT, FFT and z-transform.

- CO3 : Analyse a given signal or system using tools such as Fourier transform and z-transform to know the property of a signal or system.
- CO4 : Design of prototype of Linear Phase Filters, FIR and IIR Filter Structure.
- CO5 : Process signals to make them more useful and design a signal processor (Digital filter structures) for a given problem.